SCIENTIFIC AMERICAN SUPPLEMENT

Scientific American Supplement, Vol. I., No. 13.
Scientific American, established 1845.
New Series, Vol. XXXIV., No. 13.

NEW-YORK, MARCH 25, 1876.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.
Postage free to Subscribers.

HOW TO SET A SLIDE-VALVE.

In setting a slide-valve, we are confronted with the following considerations:

Our object is to cause the admission to expansion of and exhaust from the cylinder, of the steam equal for each stroke. This, however, we are unable to attain, because of the angle of the eccentric rod. If we set the valve so that the exhaust commences in the same relative position of the piston at one stroke as compared to the other, the valve will not admit the steam to the cylinder in the same relative position of the piston at one end of the stroke as compared to the other—

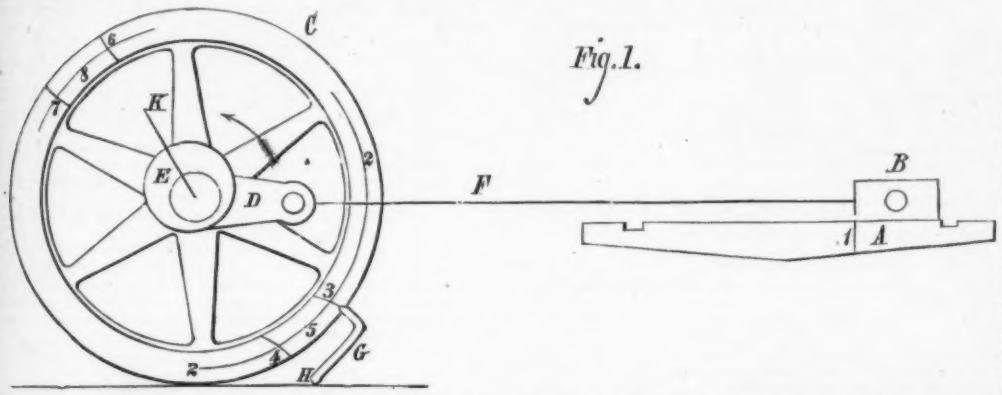


Fig. 1.

that is to say, the valve being set so that the exhaust will take place when the piston has moved an equal number of inches of the stroke at either end of the cylinder, the steam-port when the crank is on the respective dead centres will be wider open at one end than at the other. Then, again, if we set the valve so that the exhaust commences at an equal part of the stroke at either end of the cylinder, the exhaust port will be wider open when the crank is on one dead centre than it will when the crank is on the other dead centre. Whereas, if we set the valve so that the steam port at each end is open to an equal amount when the crank is on either respective dead centre, the exhaust port will also be open at each end to an equal amount when the crank is on the dead centre. Thus, by setting the valve so that it has an equal amount of lead at each end of the piston-stroke, the exhaust ports will be open to an equal amount when the piston commences its return-stroke at either end of the cylinder. It is always, therefore, preferred to set the valve so that it shall have lead to an equal amount when the crank is on the dead centre.

If the stroke of a valve is made to be twice the width of the steam-port added to twice the amount of the lap, it will be found that the steam-port at the end of the cylinder farthest from the crank will not open fully, while that nearest to the crank will have the valve travel past it to an equal amount; the degree of this difference becoming greater as the amount of the lap is increased, and hence as the amount of the lead or angular advance of the eccentric becomes greater.

The exhaust of the steam will, when the lead of the valve is equal at each end of the stroke, take place earlier in the stroke in the front end of the cylinder—that is, the end the farthest from the crank—than it will at the back end, while the steam will work expansively during a greater part of the stroke when it is in the back end than will be the case when it is in the front end of the cylinder. Having noted these facts, we may proceed to set a valve, the first operation being to carefully remove, by blowing or washing out, any filings or scrapings that may have lodged in the ports while operating upon, the valve-seat or the cylinder; the bore of the cylinder, the valve-face, and the face of its seat having been carefully cleaned and then oiled, we may connect the various parts, and find and mark the dead centres or dead points of the stroke as follows:

In Fig. 1, A represents the guide-bar; B, the guide-block; C, the fly-wheel; D, the crank; E, the eccentric, and F, the centre line of the connecting-rod of an engine intended to run in the direction of the arrow.

Giving the wheel a turn or two in the direction in which it is intended to run, we allow it to come to rest, so that the motion-block B will be at very nearly the end of its stroke on the guide-bar A, and then placing the edge of a straight edge along the end of the guide-block B, the straight edge at the same time overlapping the face of the guide-bar, we mark on the face of the latter the line 1, which will thus be quite even with the end-face of the guide-block. We then (after chalking it to make the marks show plainly) mark on the face of the wheel the line 2, which should be true with the centre of the main shaft, but which can be marked from the rim of the wheel with a pair of compass-callipers, providing that rim has been trued up in the lathe. We next, with a piece of iron wire or rod bent as shown by G, mark at some fixed point such as shown at H; make a centre-punch mark, and resting one end of the scriber G in the fixed centre-punch mark, we scribe with the other end upon the edge of the wheel the line 3, as shown in the illustration. Our next operation is to move the wheel forward in the direction in which it is to run, so that the crank will move to the dead centre, and the guide-block will leave the line 1, as shown in Fig. 2, and the motion of the wheel being continued, the guide-block will return to the mark 1, the wheel being moved very slowly indeed, so that there will be no trouble so to move it that the end of the guide-block will come to rest exactly fair with line 1. If by chance the end of the guide should move past the line, the wheel should be turned well back—that is to say, back to the end of the stroke—and again moved slowly forward till it comes fair with the line 1. The object of this is that the guide-block shall always approach the line moving in the direction in which it will, while performing that stroke, move when the engine is at work, so that all the working parts will be brought to a bearing in the direction in which they will bear when at work, and hence any spring or lost motion in any of the parts will not affect the setting of the valve.

Suppose, for instance, there was even a trifling amount of play in the eccentric or any of the bolts, and that the end of the guide-block on its return-stroke having moved a trifle past the line 1, we move the wheel backward a trifle to correct the error, thus making the block approach the line from the opposite direction to what it will approach it when at work and travelling on that stroke, then part of the movement of

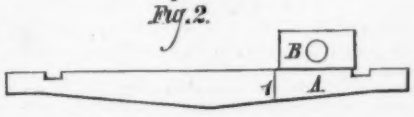


Fig. 2.

the wheel will have been lost (so far as the movement of the guide-block is concerned), having been expended in taking up the lost motion. It makes no difference if the engine is to run both ways, for in that case we observe the same precaution in moving the wheel, setting the valve in the forward gear, and then trying it in the backward gear, and dividing the difference, if any there be.

To proceed, then, the guide-block having returned even with the line 1, we take our wire scriber, rest one end in the fixed point, and with the other end mark on the edge-face of the wheel line 4, which will then occupy the place that line 3 does in our engraving. Our next duty is to find the centre between lines 3 and 4, as shown in Fig. 3, which we obtain from lines 3 and 4, and which we mark with a fine centre-punch mark, as shown at 5. And it will be readily perceived that if we move the wheel round so that the scriber G rests in the fixed centre-point as shown in Fig. 4 at A, the other

Fig. 3.

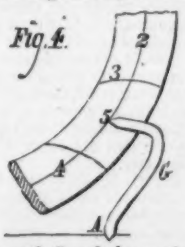


Fig. 4.

end will be true with centre-punch mark 5 and the motion-block, and hence the piston and crank will be exactly on the dead centre at that end of the stroke.

We next move the wheel around, so that the guide-block will be nearly at the end of its stroke at the opposite end of the guide-bar, and mark a line occupying the same relative position at that end as line 1 does at the other end, and repeat the whole previous operation, thus marking new lines corresponding to the lines 2, 3, 4, and 5, but on the opposite diameter of the wheel; thus we shall obtain the lines 6 and 7 in Fig. 1, and from them the centre-punch mark 8, which will serve the same purpose at that end of the stroke as does the centre-punch 5 at the opposite end.

Our next procedure is to provide a small wooden wedge,

Fig. 5

such as is shown in Fig. 5, making one end of a thickness equal to about half the amount of lead it is intended to give the valve, and the other about twice as thick as the intended amount of lead, its length being about three inches. We then move the wheel in the direction in which it is intended to run, until the scriber, one point resting in the fixed centre-punch mark, the other will be exactly even with centre-punch mark 5, and the engine will be on the forward or front dead centre.

We are now ready to set the eccentric, and the question arises, which way the engine ought to run? We have performed all our operations thus far with a view to have the engine run in the direction denoted by the arrow in Fig. 1; for had the engine been intended to run in the opposite direction, we should have drawn line 1 while the guide-block was in the same position on the guide-bar, but with the crank on the other side of the same dead centre. The direction of the arrow is the correct one in which an engine should run, if circumstances permit, for the following reasons: In Fig. 6, if we suppose A to represent the centre line of the connecting-rod, and the engine to be running in the direction of the arrow B, then the strain on the connecting-rod will be in a direction tending to compress it, the strain on the guide-bar being in the direction to force the cross-head guide-blocks down upon the guide-bars, and hence to produce the most friction; whereas if the engine was running in the direction denoted by the arrow C, the strain upon the connecting-rod will be one in a direction to pull it apart, and hence to lift it and the cross-head guide-blocks from the guide-bars, so that the centre line of the connecting-rod would stand in the direction of the line D. When the crank is on the other side of the dead centres, the same effect in either case is produced. Now it is quite true that so long as the guide-blocks fit to the guide-bars, the rod can not move in any direction, but the spring of the various parts, the direction of which is determined by the direction of the strain, is sufficient, even when the engine is new, and hence there is no play in the guide-blocks to (if the engine is running in the direction shown by the arrow in Fig. 1 and by the arrow C in Fig 6.) relieve the guide-bars of the friction due to the weight of the connecting-rod.

Having determined, then, the direction in which the engine is to be run, we place our eccentric, so that its throw-line (K

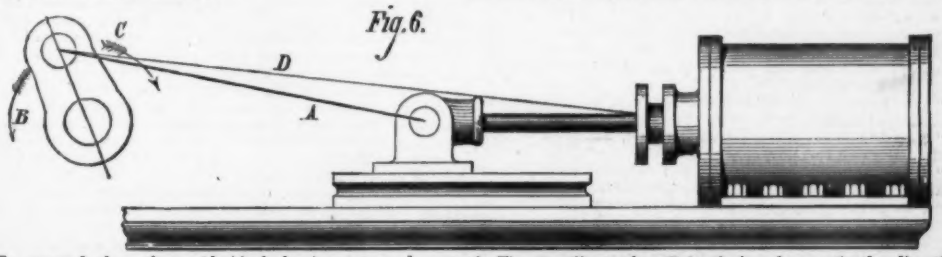


Fig. 6.

in Fig. 1) will stand sufficiently in advance (in the direction in which the engine is to run) to let the front port open to the required amount of lead, and fasten it there with the set-screw. We then measure the amount of lead there is on the valve when the eccentric is so set, by chalking the faces of the wooden wedge, and inserting it in the opening or lead of the port as shown in Fig. 7, putting it in between the edge of the valve and the edge of the port until it is a snug fit, but not forcing it in (which would compress the wood). When the wedge is home, it should be moved edgeways, and then

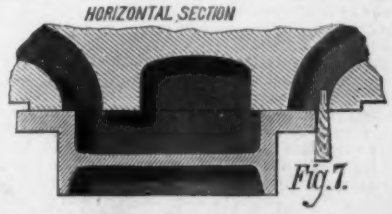


Fig. 7.

taken out, and the steam-port edge will have left a mark on the wedge evidencing how far the wedge entered, and, therefore, the precise amount of the lead at that end. We then move the wheel forward until the crank is on the other dead centre—that is to say, until the centre-punch mark No. 8 comes exactly even with the scriber-point G—and try the wedge in the back port, and if it enters at the same distance as it did at the front port, the valve is set.

If, however, there is found to be more lead at one end than at the other, it demonstrates that the eccentric rod is not the

correct length; if the front port has the most lead, the eccentric rod is too short, and *vice versa*. Locomotives and other engines, in which the height of the main shaft will vary in its relation to the height of the cylinder according to the weight of the engine or its load (as of fuel, water, etc.), should have their valves set with the load on and the engine in its working position, or moved along the rail, instead of revolving the wheel with the engine lifted off the rail.

WATER-TRAPS AND SOIL-PIPES.

Dr. Fergus, President of the Faculty of Physicians and Surgeons, Glasgow, and a distinguished sanitary authority, has for a long time given his attention to the question of the corrosion of old soil-pipes by the action of sewer-gas, and has been led to express his opinion on several occasions that the water-closet is under all circumstances dangerous, and that the whole system on which its use is based is as improper as it is costly. He inclines to the use of dry earth, or to some chemical treatment of domestic wastes. He makes no recommendation as to details, but believes that, if a small percentage of the cost of the present water-carriage system were judiciously used for experiment, some better plan would be found.

In this he proves that the water-seal of an ordinary siphon-trap is scarcely to be regarded at all as a barrier to the passage of sewer-gas, and that it has the further disadvantage of retaining enough decomposing fæces to produce within the pipe itself a sufficient amount of sewer-gas to accomplish all the evil that is feared, except such as comes by the conveyance from the sewer itself of gases containing the germs of disease originating in other houses. He made a series of experiments with a bent tube, its bend being filled with water after the manner of the usual trap. In the sewer end of the tube he inserted a small vessel containing a solution of ammonia. In fifteen minutes the ammonia had passed through the water of the trap, and had bleached the colored litmus-paper exposed at the house end. In another experiment he produced the rapid corrosion of a metal wire exposed at the house end. To prove that this transfusion takes place not only with ammonia, which is lighter than air, he made the same experiment with sulphurous acid, sulphuretted hydrogen, chlorine, and carbonic acid, all of which were transmitted so as to produce their chemical effect on the other side of the trap within from one to four hours.

He says: "We are therefore ourselves very strongly inclined to believe the last alternative, namely, that, however drains may be well trapped, sewer-gas will find its way from them into our houses; and any one who is acquainted with Graham's investigations as to the diffusion of gases will readily understand how this will happen."

The same experiments were made with a vented pipe; and although the action was retarded, it still took place. The venting was not such as is to be recommended—that is, there was no clear and direct flow of air through the pipe; but it is more effective than many devices now in use, and considered quite sufficient.

Concerning the decomposition taking place within the trap, it is his opinion that it is almost impossible, even with a copious flow of water, to cause undecomposed fæces to be discharged through the bend. With any ordinary flow there is only an eddying of the water in the trap, not a sufficient movement of the whole volume to carry floating matters under the bend. "No mere flow of water will carry out the fæces which simply kept whirling round in it."

Often, with the mistaken idea that by adding a few inches to the depth of water in the trap an effective resistance will be opposed to the pressure of sewer-gas, these are made quite deep. Dr. Fergus recommends that the dip or bend should be only sufficient to secure a sealing; for the deeper it is made, the more complete will be the retention of decomposing matters at the house side of the trap.

In view of the large amount of water being discharged, he considers it practically impossible to use any disinfectant in sufficient proportion, and with sufficient regularity, to secure a chemical disinfection of the suspended organic matters.

"Recently, I was asked to inspect some houses where there had been a considerable prevalence of typhoid fever. I believe it had been imported in the district by milk, and spread by the influence of sewer-gas; the houses were good and by no means old.

"In the interior I found that generally the water from the bath and a fixed basin passed into the trap of the water-closet, causing the water in the pan to be agitated every time the bath was discharged.

"This I consider a very bad arrangement, as the hot water would have a tendency to promote decomposition in the trap.

"Outside I found a large, deep cesspool, about 3 by 2 feet, and from 2 to 3 feet deep.

"The entrance-pipe, bringing the rain-water and house-drainage, was a little above the level of the water in the cesspool, while the exit-pipe was several inches below the same level.

"Covering the whole at the surface of the ground was an impervious stone, fitting very tightly over the opening; in fact, it was hermetically sealed.

"On removing the stone there was considerable smell, and on stirring the water a copious evolution of gas; at the same time there was a considerable deposit at the bottom of the cesspool, although it had been cleaned out only two months before.

"The surface of the water was covered with floating fæces, which was not diminished by the most copious flushing. I have already remarked that there was the charcteristic smell of sewer-gas when the cover was taken off; and that the contents of the cesspool were in an active state of decomposition, as evidenced by the copious escape of gas when the contents were stirred.

"Now, in the every-day condition of this cesspool, with the cover impervious and sealed down, where did this gas escape to? Not into the open air and not into the sewer, the opening into it being several inches below the surface of the water. It could only do so by the pipe bringing the house-drainage and rain-water into the cesspool. In a word, the decomposition of fæces in the trap of the water-closet being facilitated by the hot water from the bath, the cesspool, from its capaciousness and the depth of the exit-pipe, was as much a laboratory for the production of sewer-gas as if ingeniously contrived to be so. This gas was compelled by the close stone cover to pass either up the rain-water pipe or into the houses; it would more probably do the latter, from the higher temperature within them. I have repeatedly found the house-pipes to the drain carelessly jointed and badly laid, giving free escape to foul gas, which may, however, have some distance to travel before it finds exit, and thus render it extremely difficult to discover whence the smell originates."

Reviewing the mortuary record of the Registrar-General from 1838 till 1871, he shows, that while what he calls "excremental pollution diseases" averaged, during the first five years of the period, 298 deaths per million of the population from diarrhœal diseases, during the last five years the average amounted to 1161 per million. There was no cholera epidemic in any one of these five years. Deaths from diphtheria rose from two cases per million in 1851 to 487 cases per million in 1859.

From 1838 to 1842 the deaths from zymotics were 3770; from other causes, 18,308. From 1867 to 1871, the deaths from zymotics were 4282, and from other causes 18,059. There was a decrease of deaths from other causes, and an increase in those from zymotic diseases, showing an improvement in general vitality; while from the greater use of badly arranged closets, the local causes of deaths increased.

While referring to engineers the questions of details, he gives the following concerning the general subject of drainage:

"1. Streams should never be arched over and used as sewers; because, as the bed is always irregular and uneven, the flow will be retarded, and refuse matter will lodge and decompose in the crevices. If it is ever advisable to follow the course of a stream, then a regularly built sewer should be constructed.

"2. Care should be taken that sewers are laid in firm earth that will not 'give.' In 'made' or loose sandy soil, they should be laid in concrete, or Brook's patent might be used.

"3. If, also, sewers are to pass through walls, great care should be exercised to prevent pressure upon them from the subsidence of the said walls. This might be done by making an archway, and allowing the drain to pass under it free from all contact. When this is not attended to, the drains frequently get broken or cracked, and so allow the escape of noxious gases.

"4. The small drains should open obliquely into the larger, in the direction of the current of water running in the latter.

"5. Iron and glazed earthenware pipes should be used as much as possible for house-soil and drain-pipes—lead pipes being very subject to decay.

"6. There should be a disconnection between the house-drains and the sewers, to effect which a number of contrivances have been suggested. When complete severance can not be effected, there should be free openings both on the house and sewer sides of the trap.

"7. A plan of all the drains of each town and district should be prepared, and be readily accessible to the public; and in the same plan the subsoil of the place should be indicated.

"8. A plan of all the house-drains, showing their connection with the sewers, should be given with the title deeds of every house.

"It is quite a mistake to conceal house-soil pipes by putting them, as is generally done, in some out-of-the-way corner, covered from view, defects in them existing and producing much mischief without being suspected. Even the drains in the basements of houses should be laid in a built tunnel, covered with flags, so that, from time to time, any of them might be lifted, and the drain inspected.

"9. The laying of drains, their jointings and levels, insertion of soil-pipes, and, indeed, every thing connected with drainage, should be subjected to a most stringent and intelligent supervision."

RELATION OF SEWER GRADES TO ZYMOTIC DISEASES.

Abstract of a Paper, by Geo. W. Rafter, Assistant City Engineer, Rochester, N. Y., in *Engineering News*.

In this paper the author invites attention to the condition of sewers in the city of Rochester, assuming, as an axiom, that, whatever is true of the relation of sewerage and drainage to the public health in any given locality, is substantially true for all localities, proper allowance having been made for such differences as may be due to climate and water supply.

A sewerage system is a system of underground water-channels by which refuse matter is carried away from our habitations, and disposed of in some way not offensive to human beings.

A drainage system is a system of underground water-ways by which the surplus water is expeditiously carried out of the soil into natural water-courses. The confounding of these two systems, which should always be separate and distinct, has been the cause of no little trouble and confusion, and has in many cases been the source of serious evils to numerous large cities. As illustrating the last remark, it may be cited, a twelve-inch pipe having a grade of two inches to the hundred will carry drainage-water, with little danger of stoppage from sediment, provided the supply is moderately constant. The same pipe, if called upon to carry the sewerage of say *ten* acres, would certainly fail; it will be necessary to increase the grade, otherwise our pipe, which answered every purpose when used as a drain only, fails completely if used as a sewer, without an increase of grade.

This introduces a consideration, of which more henceforth, that the grade of a sewer is more intimately related to the duty which the sewer is to perform than might be inferred from the loose way in which they are frequently designed. Moreover, if the mere stoppage of the pipe, in the case just considered, were the only results, the damage would be comparatively slight, but following this comes a whole host of dangers. Zymotic disease extends its ravages on every side, and we find ourselves combating a destructive agent, the evils of which half a generation may not completely abate.

Physicians are agreed that the class of diseases called zymotic are, in the fullest sense of the word, preventable, preventable mainly by a due attention to sewerage, drainage, and water supply.

Now, if zymotic disease depends for its prevention upon attention to the points just enumerated, it must follow that it is a *function* of those points; therefore, its prevalence indicates incompleteness in sewerage, drainage, or water supply.

Let us attempt to trace the relation between zymotic disease and sewerage and drainage only, in the city of Rochester.

Dr. E. V. Stoddard, Professor of Materia Medica and Hygiene, of the University of Buffalo, an acknowledged authority on sanitary questions, furnishes the following table of percentage of fatal cases in zymotic diseases:

Cerebro-Spinal Meningitis	.45
Scarlet Fever	.12
Typhoid Fever	.08
Diphtheria	.05
Cholera Infantum	.18
Cholera Morbus	.02
Diarrhœa	.01
Dysentery	.07
Average	11½ per cent.

Or, for even figures, we may say that twelve per cent of all cases of zymotic disease result fatally. At this rate we have 11,300 cases during six years, in Rochester. About one in six of the whole population has been affected with some form of zymotic disease.

Here follows an account of the sewers of each ward in Rochester, and the number of zymotic cases of disease in each, from which it is shown that in those wards where there is good sewerage the fewest cases of disease are found.

As the result of the above to a certain extent cursory examination of the matter, the following conclusions are drawn:

1. That there exists a definite relation between imperfect sewerage and zymotic disease; that as sewerage approaches perfection, zymotic disease decreases, and conversely.

2. That the grade of a sewer should be a *true grade*, and as great as can possibly be attained.

3. That pipe sewers are vastly preferable to the old-fashioned, square-box, stone sewers, without artificial bottoms, still in use in Rochester and many other cities.

4. The sectional area of a sewer should be as small as is consistent with a due regard for the greatest amount of work it is likely to be called upon to perform.

5. Sewers should be deep enough to give a grade of at least three feet from the most remote house connection to the street.

6. In designing a system of sewerage, two things are to be considered, average water supply and average amount of sewerage matter to be disposed of; hence, we have the following general law: *The inclination or grade of a perfect sewer bears a definite relation to the average water supply, and to the amount of sewerage matter to be disposed of.*

COROLLARIES.

1. Other things being equal, the inclination should increase, as the amount of water to be regularly supplied decreases.

2. For a given inclination, the water supply should increase in proportion to the increase of sewage matter to be disposed of.

3. For a given amount of sewage matter to be carried away, the inclination should increase as the water supply decreases.

4. For a given water supply, the inclination should increase, as the sewage matter to be carried increases.

5. The inclination may decrease as the water supply increases, sewage matter remaining constant.

6. The inclination may decrease as sewage matter decreases, water supply remaining constant.

In conclusion, it may be remarked that the uniformity of natural surface-configuration throughout the whole city renders Rochester an excellent example for a comparison of the kind here attempted. There are no conditions of surface in one part of the city which are not balanced by similar conditions in other parts.

FRENCH CONFECTIONS.

France supplies all nations with her *dragées*, her *sucres cuits*, her *pâtes*, her *nougats*, her *pastilles à la goutte*, her *pralins fondants*, etc., her *fruits au sucre*, and her *liqueurs sucrées*. The production, on an ever-increasing scale, is aided in general by the employment of steam, and steaming and mechanical apparatus, which produce more regular results. In the manufacture of the description of bon-bons called *dragées*, the old basin known as the *bralante*, and which was heated by a brazier of half-lighted charcoal covered with a few cinders, and was moved to and fro, and its contents stirred by hand, has been superseded by a special apparatus, warmed by steam, and to which is imparted a rotatory and oscillating motion, regulated by a suitable mechanical arrangement. By this invention a workman can make 260 to 280 lbs. of *dragées* per day, as against 20 to 25 lbs. by the old *bralante*, and this under more favorable hygienic conditions, for the former apparatus exposed the workman to emanations of carbonic acid and oxide of carbon, exerting a deleterious influence on his health. In short, from eleven to twenty years' superintendence of the *bralante* sufficed to ruin the health of the unfortunate workman. Thus, life may be said to have been sacrificed in the production of *confiserie*. The sensitiveness of sugar, which is the basis of confectionery, after it has passed the melting point to varying degrees of heat as shown in the changes it undergoes, requires no ordinary care and skill in regulating the heat and watching the results. There are six essential degrees at which the syrup of sugar should be boiled, which French confectioners recognize as the basis of their art: 1. *La lisse*, a thread, large or small, obtained by dipping the forefinger in the syrup, pressing it to the thumb, and then parting these; when, should it break at a little distance, leaving a drop on the finger, it is the small thread; if at a greater distance, the large thread. 2. *La perle* (the pearl) which is the small pearl, when it will but just allow the thumb and finger to be slightly separated without breaking, and the large pearl, when the thread remains intact, though finger and thumb are at their utmost stretch. There is a somewhat uncertain test by which this last condition of the sugar may be indicated, and this is by round and raised bubbles appearing on the surface. 3. *Le soufflet* (the blow). This condition of greater tenacity is shown by the emission of sparks of light, the reflex of innumerable small bubbles, on blowing and shaking the sugar in a skimmer which has been dipped into it. 4. *La plume* (the feather), where the bubbles are larger after the foregoing process. 5. *Le boulet* (the ball), when the finger, having been dipped into cold water, then into the sugar, and then into the water again, it appears as a small ball, or larger and harder, when it takes the name of the great ball. 6. *La casse* (the crack), when the sugar, on being suddenly dipped in water, exhibits this tendency through change of temperature. But we are, perhaps, wearying the reader, and will turn to the *confiserie* itself. Chocolate confectionery is entirely of French invention. The manufacture of the sweetmeat is concentrated in Paris, and gives employment to 800 workmen, the value of the annual production being not short of £220,000. The excellence of the productions is largely due to the improvements carried out in triturating and grinding. The French confectioner displays much ingenious skill in casting a variety of subjects in chocolate, which are usually afterwards glazed with preparations of sugar, and colored to represent natural objects; among the favorite types are fruit, vegetables, cockchafers, spiders, and other insects. The moulds used are of hammered sheet copper. Powdered sugar beaten with the whites of eggs enters largely into French confectionery, the composition being stamped or cast in moulds, as, *par exemple*, into a flower, plant, or bird, undergoing, in short, the most various transformations. In the class of confectionery termed *nougats*, the kernels of nuts, especially almonds, are encrusted with sugar compositions. The *pâtes* and *pastilles* of gum constitute a leading specialty, but the high price of the gum, from

decreased importations, has tended to limit the production and check consumption. An important branch is in *sucres cuits*, boiled, baked, or blended with water, and afterwards passed through rollers to give it the requisite ductility, when, after undergoing numerous manipulations, forms are printed from it in relief, or made to represent roses, flowers, letters, etc. The value of the sugar confectionery manufactured annually in France is at least £350,000. Marvellous is the ingenuity and apparently inexhaustible the invention displayed in this branch, the designs including intricate interlacing of fruits and wonderful crystallizations. French confectionery art of design has had its influence on English taste, as witness the present and past appearance of our confectionery establishments. We have more of design and less of shapeliness in sweetmeats. Preserved sugared fruits and fruits in syrup constitute in France an important article of *confiserie*. There are the fruits candied, or *glacés*, such as pears, apples, prunes, peaches, nuts, cherries, citrons, angelicas, and even chestnuts; or those presented as marmalades or jellies. The preparations have been vastly improved of late years, especially by the application of steam. It is not Paris alone that is concerned in this branch. Some of the houses of the south of France are remarkable for the excellence of their productions. There the preparation of whole fruits for the purpose is chiefly carried on. The Parisian confectioners show great taste in their boxes and the arrangement of the fruit, and have a high reputation for fruits in syrup. In short, they have gained almost a monopoly in supplying the world with conserves. The principal French *liqueurs sucrées*—which, by the way, are making a somewhat slow but steady advance in this country—are the *liqueurs curaçoa, chartreuse, cassis, maraquin, kümmel, punch, crêmes*, which may be divided into many qualities, of which the three following are the principal: 1, *ordinaire*, which has 20 per cent of sugar and glucose, and 20 per cent of alcohol, the rest being water; the fine quality with 40 per cent of the former and thirty of the latter, and the extra quality with 50 per cent of pure sugar and 30 to 35 per cent of alcohol. In this class are the spirituous bitters, such as absinthe, *elixir de longue vie, vulnéraire*, and *vermout*, also syrups of gooseberry, raspberry, orange, etc.; also candied fruits or *compotes*. Certain of these products, by leading makers merit high praise. To acquire its full-bodied qualities, a *liqueur* should be long kept, and under conditions favorable to conservation. Some French *liqueur* manufacturers have not the necessary capital for this purpose. The French especially manifest their superiority in comfits containing fruit essences, candied fruits, and preserves and jellies.—*National Food and Fuel Reformer.*

[Medical and Surgical Reporter.]

ON THE VALUE OF FOOD.

THE secret of all improvement in the human race is the development of conscious aims. Dr. Whewell has shown this strikingly in his *History of Scientific Ideas*. It is indorsed to the fullest by history. The nation which pursues a clearly-seen object is sure to reach it. When, therefore, we indulge in plans for the regeneration of the race, a harmless and even praiseworthy pastime, we must begin with the reformation of ideas.

The idea is the only permanent thing in organism. It is indelible. The primordial cell, which after fruitful intercourse represents the future man, has somehow stored up in it—*potentially* in it, we say, so as to clothe decently our ignorance—all the thoughts and experiences of both father and mother, even those they themselves have forgotten or *never knew*. This last seems an extravagance, but it is literally so. Tricks of gesture and expression during sleep, of which the person is himself unaware, have been known to be handed down from generation to generation.

But the wonder does not end here. It but begins. Not only the thoughts and experiences of the immediate parents, but of all ancestors on both sides, are in this microscopical globule, ready at once to spring up, like flowers or weeds, whichever they may be, as condition dictates. Psychologists call this the principle of ancestral or atavistic reversion.

How shall we account for it? The mystery lies in the relation of memory to its organic correlatives. Every sensation or thought is connected with an impression on the nerve centres. Reduced to its lowest terms, such a statement is that to every thought corresponds a motion. Not that the motion is the thought; this is the fallacy of materialism. Nor that the thought causes the motion; this is the absurdity of idealism. But that by the parallel operation in different directions of the same abstract law the motion *corresponds* with the thought, is synchronous with it, and of like extent.

The relation of the two is called, by Dr. Thomas Laycock, the *syneis*. His observations on the subject are in the July number of the *Journal of Mental Science*, and he illustrates copiously the connection of the idea and its organic base.

This relation can be modified in various ways, but by none more easily than by *nutrition*. The practical foundation of culture and virtue is food, good and abundant food. A family half starved or improperly fed for a few generations can not produce vigorous brains. Whatever vigor they have goes to the reproductive organs. Notice, when you mow your lawn in summer, how tall-growing weeds shorten their stalks so as to blossom beneath your scythe; so wretchedly-fed races are usually prolific. Plato, Cicero, Dante, Shakespeare, Bacon, Newton, Pascal, Goethe, Napoleon, founded no families. Their brains absorbed their desires or their powers.

Before the golden year comes round, every man, woman, and child must have sufficient digestible food for a few generations. Famine, hunger, as it is the first, so it is the last enemy to the happiness of man.

[Mill-Stone.]

FANCY MIDDLINGS FLOUR.

MIDDLINGS, as is well known to every one familiar with grinding wheat, consists of coarse particles of the kernel from immediately adjoining the skin of the berry, and now appreciated as the most valuable part because consisting largely of "gluten," while the interior of the kernel is composed of the starch, which when dry readily becomes a pearly powder.

Under the method of "straight grinding" almost universally practiced until within a very few years, the prime object of the miller was to make as few middlings as possible, considering them only fit to be ground into an inferior grade of flour, or high grade of feed.

Consequently the grinding was done very "close" with keen, sharp burrs, shaving into powder as far as practicable all this compact horny part of the kernel, which thus became incorporated with the interior or starchy part, and through the bolt was separated from the bran or skin of the berry, and the coarse particles which escaped being shaved down. As before stated, these coarser particles are known as middlings, and remained mixed with small particles of bran and other foreign substances, also a fine furze, which is found on the skin of the berry.

How to free the middlings of these impurities or separate the hard angular particles of the kernel from the other substances was known to but few, and hence the whole could be marketed only as refuse, or the amount lessened by regrinding, and a cheap grade of flour obtained as before stated. Spring wheat especially partakes largely of this horny glutinous nature, and hence it was difficult to work it profitably into good grades of flour.

Suddenly, not many years since, the world was filled with the words, "New Process." Few understood what it meant, but the millers of the northwest felt that their Bonanza was at hand, and the common people wondered how their spring wheat was made into flour equal to the best Baltimore and St. Louis brands, while wiseacres throughout the country became powerful with marvellous patents and ate up the substance of honest millers.

This new process consists in manufacturing a flour out of the middlings, having larger and more uniform granules than the flour which is made from the central part of the berry, and free from the fine impurities admixed with the first grinding.

The middlings are passed through a machine called a purifier, so arranged that a properly regulated current of air may be sucked or driven through them, separating all the furze and small specks, which have less weight than the particles of the kernel thus freed of impurities. The purified middlings are then reground, and great care is taken to have the "middling stone" very accurately dressed with perfectly true face, so that the grinding may be even and the angular shape of the particles retained. After grinding it is bolted as usual through proper numbers of cloth, and the larger particles passing over the tail of the reel returned to the purifier and stone.

This is a general synopsis of the process, which is of course varied to suit the judgment and experience of skilled millers, some using many purifiers for frequent separations and different methods of manipulating the returns and regrinding.

The middlings flour being sought after as superior to the straight grade, it will readily be seen that it is desirable to "grind high" (a term used by millers to designate the raising of the running stone from the bed-stone) and make as much middlings as practicable—frequently 35 to 40 per cent is made into middlings flour, and some claim 50 and 60 per cent and even more, but their statements should be received with reserve.

In mills where they make a specialty of fancy middlings flour, the most skilled stone-dressers are employed, and no care or expense spared to have the face perfectly true and very smooth, both face and furrow. The furrows are shallow and wide, about an eighth of an inch deep at the back, not more, and so wide that there is even more furrow than face—commonly in four feet stones two inches wide, and we know some of high reputation two and one quarter, and even two and three-eighths wide—fourteen leading furrows, with two branch furrows to each. A few days since, while at the new seven run mill, which we have just built for Messrs. Redmon, Cross & Co., of Prescott, Wis. (20 miles south of St. Paul), we examined the face of the stone made ready for work by their experienced head-miller, a marvel of skill and beauty, the entire face being as smooth as marble, and sufficiently accurate to pinch a thought. Having with skill and accurate tools prepared the stone, the chop is ground cool and sandy, as high as proper regard for yield will admit, running slow—not over one hundred and fifty, and in some instances one hundred revolutions for four feet stones—in order to clear the bran nicely.

The principle is to crush the berry and separate the kernel from the bran by grinding, the old idea being to shave off the bran and shave down the kernel.

While there is no doubt about the superior excellence of the middlings flour, there is a grave question as to its being profitable for mills to attempt to make especial efforts towards its manufacture, considering the small difference in price from straight grade, and increased expense. Especially is this the case with winter wheat, which has thin, tough bran, susceptible of being removed readily from the kernel without breaking into small specks, while the glutinous part of the kernel is softer and less tough, and consequently more readily admitted with the starchy interior at the first grinding.

Yet there can be no question as to the economy in every merchant mill having a Middlings Purifier in order to utilize the middlings necessarily made.

[N. Y. World.]

POPPED CORN.

FOR the exclusive privilege of selling popped corn on the Exhibition grounds the Company receives $7000.

The pop-corn trade of New-York and its neighborhood is in the hands of one person, E. Houston, 28 Thompson street, one of the murkiest-looking in the row of dirty basements which line that thoroughfare, the only relief from the general slovenliness being the great baskets of pop-corn balls, red and white, and large tubs, holding many bushels, heaped up with the freshly exploded grain. There is a sweet smell in the atmosphere, partly resulting from the pans of syrup and sugar which stand about, and also from the popping paraphernalia in the back basement. In a large open fireplace a coke fire is built, fifteen inches broad by over three feet long. Overhead, from the top of the fireplace, a chain with hook is hanging. The "popper" is precisely the wire cage which is shaken vigorously over a thousand country kitchen-fires, in every respect but size. In place of holding a quart or less, this holds a half bushel of the fluffy popped grain, and has a broomstick for a handle. About a quart of the shelled corn is thrown into the cups, the fire-lid closed and the popper put into position, the handle resting in the swinging iron hook. A gentle shaking gets the kernels warm without letting them burn, and presently they are exploding away with an accumulating rattle like the opening of toy musketry in volleys. The faster they burst the quicker they must be shaken to keep the tender new surfaces from burning. In less time than it takes to describe the operation, the cage is full past shaking with a snowy-looking mass, which is at once emptied into a tub set near. Without delay a fresh batch of grain is thrown in. When the work is in full blast the scene is a lively one, the expert (and it requires no small amount of dexterity to keep the whole moving on without hitch or delay) turning quarts of grain into half bushels of popped corn with wonderful celerity.

If the puffy kernels are to be sugar-coated, they are placed in a pan and shaken up with syrup, coloring matter is added, and sometimes, in place of plain sugar, a chocolate color and flavor are given. If the corn is to be worked into balls, a mixture of sugar, syrup and gum is poured over it, and the children roll it up. Two little girls sit before a tub of the moistened material, and, taking up a handful, deftly press it into shape, very much after the method of snow-ball manufacture. The red coloring is added by a third assistant, who, from time to time, moistens her hands with a preparation of cochineal. If the "pop-corn cake" is to be made, the corn is moistened with hot syrup or molasses boiled just to a "crack," pressed out into sheets and cut into sections. These are about all the forms into which the article is turned.

Mr. Edward Houston, the pop-corn monopolist, is a slight, energetic man, who readily spoke of the trade and his work in it. "I have been here eight years," he said, "and the man before me was here as long. There are a couple of other places in town, but they only pop a little. I supply most of the New-York trade, and for from 50 to 100 miles about here. In fact, it goes all over. I have shipped it to Michigan, to the South, and some has gone across the ocean. I make, on an average, over twenty bushels of popped corn a day. February is our dull month. In December and January, the Sunday-school and Christmas celebrations make a demand for pop-corn, and in summer the trade is always good, mainly for balls. In winter the demand is for corn-cake—this mixed with molasses. A bushel of shelled corn will make nearly four barrels of popped stuff, and I use up generally about six bushels a day. In getting the corn, I have to make special contracts with farmers to raise it. It can not be bought in the market except now and then in job lots. I had one man in Connecticut who raised to my order last year, 1500 bushels of corn in the ear, and I bought 200 bushels from another. The bulk of what I get is ordered a year ahead, otherwise I should run short. The corn is not shelled with an ordinary sheller, as that breaks the kernel and spoils the popping. The kernels are threshed off by putting all in a bag and pounding it. There is a big difference in corn; some is cheap at $4 and some dear at $1, as it will not pop. I sample all I buy and try it in the popper. It must be kept over one year to get thoroughly dry. If properly managed, not a grain is burnt. It makes no matter whether the grains be red or white; they turn completely inside out and look the same. The plain popped corn is sold by me for $2 per barrel when made up in bales. I wholesale them at 45 cents per hundred, or $3.75 per barrel, and they sell at a cent a-piece in the shops. The trade does not feel the hard times at all. I suppose the children keep on eating."

The trade is, indeed, increasing; two corn-balls are eaten nowadays where one was eaten before, and the Centennial speculator, if the large profit and large sales of the business be any guide, will make a respectable profit over and above the $7000 he pays for his franchise.

PROCESS OF RIPENING OF GRAPES.

C. NEUBAUER.

THIS investigation proves a remarkable difference between the processes of ripening of kernel fruits and that of grapes.

While the former reach a point when the infusion of new material from without ceases, the process of ripening being not completed, grapes depend for their ripening altogether on the grapevine, until this process is completed. Grapes, therefore, will not mature after they have been removed from the vine, like apples and pears, which can be removed without injury as early as twenty days before the time when the farmer considers them ripe.

If the grape-stem become injured the grapes will slowly dry up, and the berries no longer gain in sugar. While in uninjured grapes the proportion of acid to sugar was found to be 1: 21.7, injured grapes, of the same age, gave a proportion of 1: 15.4.

The question, whence the sugar in the grape is derived, is answered by the author to the effect that it is all derived from the plant and not formed in the berries. The amount of cellulose, which is never great, can hardly produce the sugar. Pectin can not be suspected, since no chemist has as yet been able to convert these substances into sugar; and the theory based upon the fact that the amount of acid decreases while that of sugar is increased, a fact which has induced many to believe that acid may be converted into sugar, becomes doubtful when we observe in the results of these examinations other causes leading to a decrease of free acid. The large increase of inorganic constituents, during the latter period of the process of ripening, explains this anomaly sufficiently well. The sugar must therefore be derived from the plant. His examinations of the grapevines have yielded him the following results:

1. Leaves, shoots, and young twigs contain no inconsiderable quantities of sugar, which may easily be separated from the other constituents and fermented.

2. Leaves, shoots, and young twigs are very rich in hydropotassium tartrate, pectin substances, and *oxalate* of lime.

3. Those substances of the must which produce the peculiar ethers of wine are likewise contained in other parts of the plant.

AMERICAN GRAPEVINES IN GERMANY.

THE introduction of American vines into German vineyards is decidedly on the increase. Dr. A. Blankenhorn reports 84 different kinds which are now grown there, without taking the responsibility that this list is complete.

[Ohio Farmer.]

CULTURE OF THE ARTICHOKE.

IF we take into account the ease of culture, freedom from ravages of insects and surprising yield, also that it requires no protection through winter, freezing not injuring it in the least, I think that the artichoke would take the front rank among root crops to feed stock. Five years since, while conversing with a practical old farmer on the subject of raising roots to feed stock, he gave it as his opinion, based on experience, that there was no other root as cheaply raised or that yielded so heavily as the artichoke. The course that I have adopted in raising them is the same as for the potato, they may be planted either in hills or drills, and as the frost does not injure them, they may be planted as early in the spring as the ground is ready. As they make an immense growth of tops, the tubers do not form until fall, about the time they blossom; but then they grow very rapidly, probably as much in one week as the potato does in four.

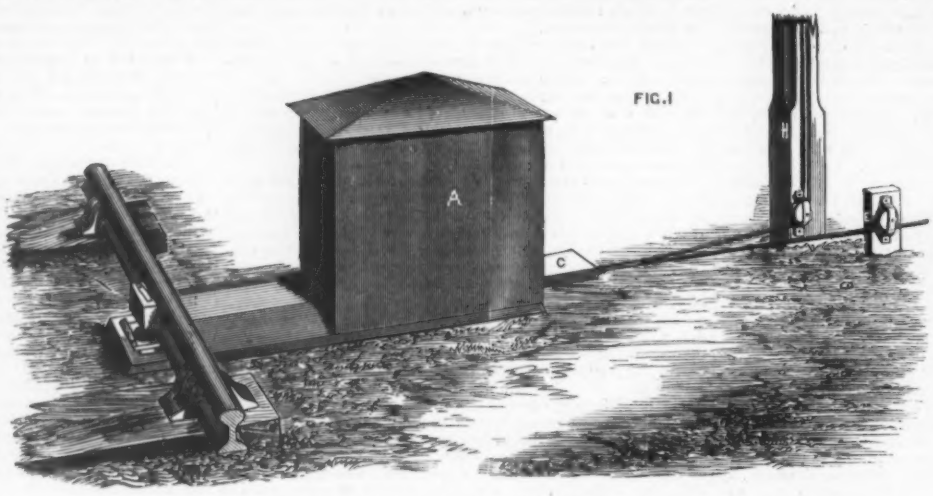
WILLIAM WADE.

M. DUCHEMIN has found that nickel, deposited by electricity on the magnets of compasses, preserves them from oxidation.

EXPLOSIVE RAILWAY-SIGNAL.

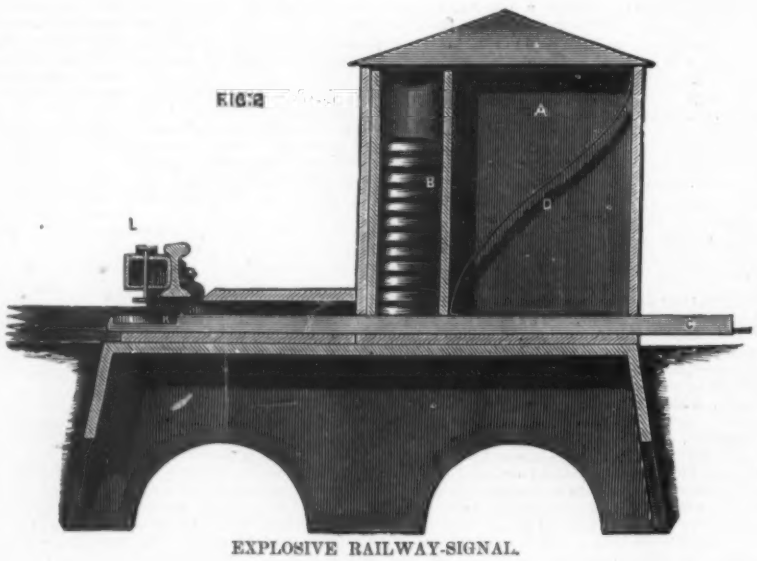
THIS invention has for its object the placing of the signals in a situation where they will be exploded by a passing train through the agency of the signalman alone.

Fig. 1 is an elevation and Fig. 2 a section of Mr. Aird's apparatus, which can be modified in various ways. It consists of a box A, within which is placed a number of fog-signals B, Fig. 2. These rest on a sliding bar C, at one end of which a small depression is made to receive the signals, as shown in the engraving. The slide C is urged forward by a spring D. To one end is secured a rod or wire E going to the signal-box. The end of the semaphore post is shown at H. Every time the semaphore is worked, the slide moves in the bottom of the box; but when the slide goes forward, it carries with it one of the fog-signals from the bottom of the pile, and conveys it to the position shown in Fig. 2 at K. At L is shown a striker kept up by a spring. As an engine-wheel runs over this striker, the latter is forced down on the fog-signal, and explodes it. Subsequently, when the lever is put to "line clear," the slide C is brought back, and then receives another fog-signal, and as soon as the semaphore is put at "danger," this signal is ready to be exploded. Should it happen that no train runs over it during this time the fog-signal is drawn back into the box when "line clear" is shown, and is then still ready for use.



EXPLOSIVE RAILWAY-SIGNAL.

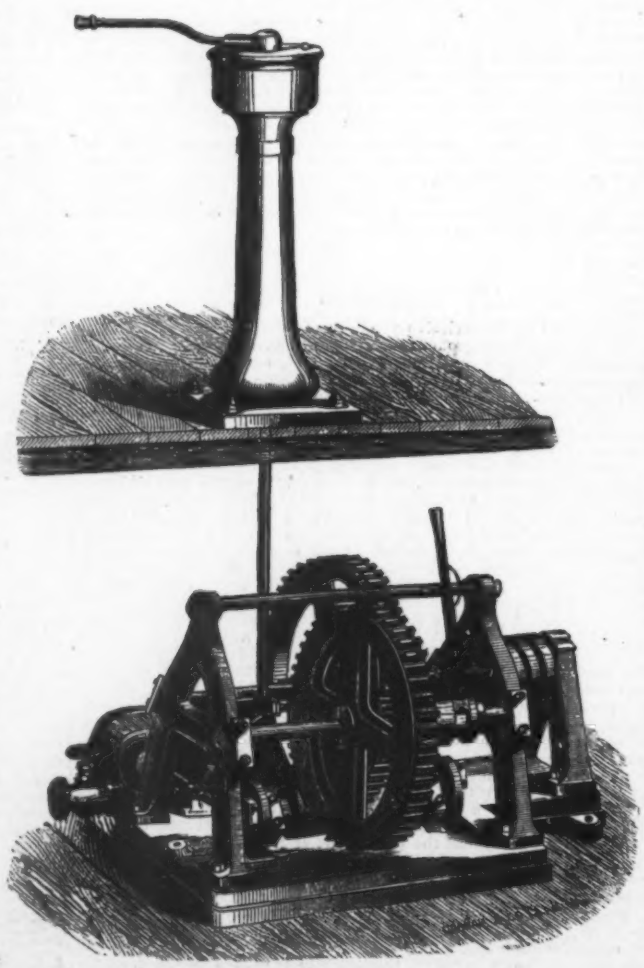
The following advantages are claimed for the apparatus: (1) It saves the labor of men stationed at the signal-post to place the fog-signals on the rails when necessary. (2) It can not get out of order. (3) It can be made to carry any number of fog-signals. (4) It is impossible either in fine or foggy weather for an engine-driver to pass any signal (where the apparatus is placed) without *hearing* the signal, should he (the driver) not see the arm at danger. (5) It supplies itself, and should the signal not be fired, it (the signal) is taken into the box, when the signal-arm is drawn to "line clear," and resumes its place under the rail the moment the signal-arm is released to danger. Should the signal be fired, the act of drawing the signal-arm to "line clear" removes the broken case, which is replaced by another sound fog-signal. (6) The apparatus is not expensive, being very simple in its parts, and the case or box might be cast in one piece. (7) No brick or other foundation is required, the apparatus being simply sunk in the ballast. (8) No additional length of wire rope is necessary. (9) The fog-signals and the working parts are amply protected against rain, dust, etc. (10) The apparatus being placed outside or at any distance from a signal-cabin, a train could be stopped at once, at the will of the signalman.—*The Engineer.*



EXPLOSIVE RAILWAY-SIGNAL.

IMPROVED STEERING APPARATUS.

THE great resistance of the rudders of our large modern ships renders it impossible to move them by the simple apparatus of former days, and various methods of applying steam and other power to the operations have been invented. One of these, manufactured by Bow, McLachlan & Co., Paisley, is illustrated by the annexed engraving. This invention has for its object the simplification of steering machinery, in which steam-compressed air or water is employed for moving the rudder. It consists principally in setting the engines in motion by means of a handing-shaft, having on it a hand-wheel to be turned by the steersman, or a lever, as in our illustration, and a worm which gears with a worm-wheel on a slowly moving shaft, transmitting the force of the engines to the rudder through screw, chain, or other usual gearing. The handing-shaft acts by collars on a lever fixed on a rocking shaft, which acts on the valve-motion links or valve details, and when this handing-shaft is turned by hand the worm works through the teeth of the worm-wheel, so as to move the shaft on end, and thus through the lever and rocking-shaft act on the engine-valves in a manner to make the engines turn in the required direction. This turning of the engines, by giving motion to the shaft having the worm-wheel on it, makes that worm-wheel act on the worm as a pinion does on a rack, and thereby move back the handing-shaft to its neutral position. The rocking-shaft may act on ordinary link-valve motions, or other known equivalents; it is, however, preferred to actuate the slide-valve of each cylinder by means of a single eccentric, and to obtain the reversal or stoppage of the engines, by interposing between each valve and the cylinder port-face a plate with two sets of passages in it, such plate being movable by a rod connected to a lever on the rocking-shaft. In the middle of this plate the cylinder ports are closed, and on moving it in one direction, what may be termed its direct passages are put in communication, whilst if it is moved in the opposite direction, its other passages, which are indirect, are brought into communication, and cause the reversed action of the steam. The peculiarities of the invention in brief consist chiefly in the combining of a worm on the engine handing-shaft, or on a shaft connected with it, with a worm-wheel on a shaft driven by the engines, and the interposing of the movable plate with direct and crossed passages between the cylinder and the slide-valve. Its advantages may also be shortly summarized. The working is done by one man, and the strict fulfilment of the officers' orders is thus insured. The apparatus can be adapted to work rudder-chains, or through screw-gear, by wheel or tiller, which can be done by no other steam-steering engine, and it can be disconnected with certainty, and the hand-gear applied in a few seconds. It is remarkable for the fineness of its working parts, so that the complication, unnecessary expense in first cost and maintenance are obviated, and it can be easily understood by any engineer. All the valves are steam-tight, and there is an indicator to show the position of the rudder. Lastly, in the event of the rudder being hard over and a sea striking it, it runs the gear back, but in no way affects the engine; when the rudder is hard over to port, the engine can not be turned any farther in that direction; the wheel may be turned, but it will not affect the engine, which can only be turned by turning the wheel to starboard. They have now been fitted to some forty steamers of all dimensions.—*Iron.*



IMPROVED STEERING APPARATUS.

NEW PUMPING MACHINERY.

AT one of the most extensive of the shale-pits on the banks of a tributary of the Almond, near the village of Mid Calder, and which is 43 fathoms in depth, it was found necessary a few months ago to erect new pumping machinery to keep the working dry while working the lowest seam of shale, which is 4½ feet in thickness. The order was intrusted to Messrs. A. Barclay & Sons, of Kilmarnock, who have turned out machinery of novel construction, and which has been found to work with great efficiency. The engine, of the overhanging beam class, high-pressure and condensing, has a steam cylinder 62 inches in diameter, with a stroke of 8 feet, which gives a stroke of 10 feet in the pumps. The beam is made of solid wrought-iron plates, 30 feet long, consisting of two plates 1¼ inches thick, thoroughly bound together. The pump-rods are hung between these plates at the pit-end, and the steam cylinder is just within the rods, the back end of the beam being supported by a vibrating column. By this arrangement, the pit head is kept perfectly accessible and unencumbered by machinery, the importance of which will be obvious. The engine is fitted with the most improved system of valve-gear, working two Cornish valves in the one steam-chest with the equilibrium-valve between. The condenser is of the blow-through type so successfully applied by the engineers to the largest pumping engines. It is claimed for this form of condenser that it has no working parts which will go wrong or require to be kept in repair, and that at all times it gives a steady vacuum in the cylinder. The pump worked by the engine is of the plunger class. The plunger is 27 inches in diameter, working a 10-feet stroke, and weighs 8½ tons. The rods to which the plunger is attached are made of pitch pine 14 inches square, in lengths of 40 feet, bolted together at each joint by four malleable iron plates 20 feet long. The rising column of pipes are 22 inches in diameter. Before being sent to the pit, all the pipes, clack pieces and working barrel were tested in Messrs. Barclay's works to a pressure of 450 lbs. to the square inch. The heavy weights which had to be lowered down the pit necessitated the use of a very powerful crane, which was also constructed by Messrs. Barclay & Son, and has been fixed permanently on a stone seat for future use in connection with the pit, and this crane is capable of lifting 20 tons as a working load, but has been tested considerably above that point. It is driven by a single 8-inch cylinder working with screw and worm-wheel on the first motion, and reduced with spur gearing to the drum. The drum is 54 feet diameter supported on three strong cast-iron rings and covered with wood cleading. The rope is 6½ inches in diameter. The total weight of the material in connection with the pumps in the pits is about 150 tons, and of the engines above ground 70 tons. The power of the machinery may be estimated from the fact that 1500 gallons of water can be discharged per minute from the pit into the adjoining stream.

A WEEK'S WORK.

ACCORDING to a statement in the *Engineer*, a week's work in Birmingham comprises, among its various results, the fabrication of 14,000,000 pens, 6000 bedsteads, 7000 guns, 30,000,000 cut-nails, 100,000,000 buttons, 1000 saddles, 5,000,000 copper or bronze coins, 20,000 pairs of spectacles, six tons of papier-mache wares, over £30,000 worth of jewelry, 4000 miles of iron and steel wire, ten tons of pins, five tons of hairpins, and hooks and eyes, 130,000 gross of wood screws, 500 tons of nuts and screw bolts and spikes, fifty tons of wrought-iron hinges, 350 miles' length of wax for vestas, forty tons of refined metal, forty tons of German silver, 1000 dozen of fenders, 3500 bellows, 800 tons of brass and copper wares—these, with a multitude of other articles, being exported to almost all parts of the globe.

BLAST-FURNACE CHARGING APPARATUS.

THE advantages derived from working blast-furnaces with closed tops are being largely recognized, and we give illustrations showing an arrangement of charging apparatus, manufactured by Messrs. Weimer & Birkenbine, blast-furnace engineers, of Lebanon, Pa.

According to this plan, the tunnel head of the furnace is fitted with the usual form of bell, hopper, and lip-ring, the lower part of the bell and the bottom of the lip-ring being turned off so as to make a tight joint. On the top of the hopper is placed an iron cover, provided with three or more

FIG. 1.

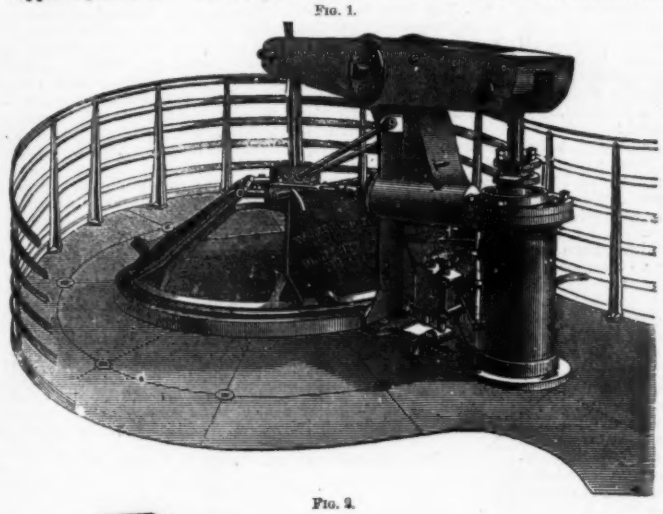


FIG. 2.

BLAST-FURNACE CHARGING APPARATUS.

openings (the engravings show three openings), which can be closed at will by sliding doors. The rod supporting the bell passes through the top of the cover, and is attached to one end of a beam, which is supported upon a casting of sufficient strength, combining two cylinders, one horizontal and the other vertical, with their necessary ports, etc. The piston in the horizontal cylinder is connected by means of piston and connecting-rods with a revolving plate on top of the cover, to which the doors are attached. These doors are hung on hinges, so that in case of any excessive pressure they will open, or it may at some time be desired to lift one or the other of them. The piston in the vertical cylinder is connected by a piston-rod with the end of the beam opposite that to which the bell is attached.

The engravings show the bell closed and the hopper ready for its charge, which is supplied by means of the usual charging barrows dumped through the open doors. When the charge is to be dropped, the attendant depresses the left-hand lever, shown in Fig. 1, which, admitting steam into the horizontal cylinder, causes the plate on top of the cover to revolve and carry the doors with it, thus closing the openings. A small safety-valve placed on the cylinder prevents risk of damage by too sudden closing. When the doors are closed, the right-hand lever, Fig. 1, is raised, which, by admitting steam into the vertical cylinder, drops the bell and its charge. By depressing the same lever, the bell is raised again to its position, and the valve arrangement is such that the movement is under the easy control of the operator, who can bring the bell to its place as gently as he pleases. The screw on the rod supporting the bell admits of its exact regulation, and the swivels admit of perfectly free motion; the top of the cover acting as a guide.

When the bell is in place, the left-hand lever, Fig. 1, is raised, which causes the doors to open. Fig. 2 is a view of the apparatus with the bell dropped and the doors closed; it also shows the opposite side of the supporting casting. The apparatus can be operated by steam, air, or water-power, and can readily be removed in case any repairs are necessary at the tunnel-head. Special provisions are made to obviate difficulty when a bell falls into the furnace or accidents occur. The only gas which escapes is, obviously, so much as can be contained within the space between the bell and the cover—a very small amount. Mr. Weimer states that with the usual mode of dropping the bell, a fair approximation of the daily waste of gases from a moderate-sized furnace would be from 60,000 to 100,000 cubic feet, a quantity which is surely worth utilizing. This apparatus also obviates the necessary changes in temperature and pressure, which must follow the opening of the full area of the tunnel-head every few minutes.

IMPROVEMENT IN THE MANUFACTURE OF GAS.

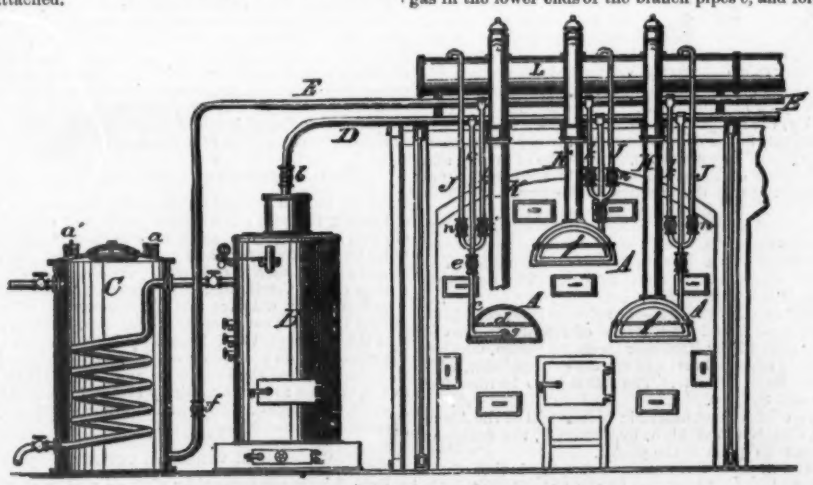
By G. OLNEY, Brooklyn, N. Y.

I HAVE found that, when a hydrocarbon mixed with steam is injected into a highly-heated retort, the hydrogen set free from the steam does not readily combine with the coal-gas; but if common coal-gas, mixed previously with steam and a gas from a hydrocarbon, is injected into the retort, a chemical union of the gases will quickly take place, and a perfectly-fixed gas will result. This is evinced by the fact that a steady light is obtained, that no stratification of the gases in the pipes is found, and that the coal-gas produces a much larger volume when it is treated with the hydrocarbon fluid and steam.

A, bank of retorts; B, steam-generator; C, reservoir for petroleum. Two valves, *a a'*, are applied to the top of the reservoir C. One prevents a vacuum being created therein, and the other allows the escape of air while filling the reservoir. D, steam-pipe, with regulating-cock, *b*, and from which branch pipes *c* are carried down into the front end of each one of the retorts A, terminating beneath the diaphragm *d* therein in a flattened injecting-nozzle, *g*, which is directed towards the rear end of the retort. When coal is used in retorts, the diaphragms *d* are omitted. A regulating-cock, *e*, is applied to each branch pipe *c*. E, a pipe from the bottom of reservoir C, and provided with a regulating-cock, *f*. From E descend branch pipes, *k*, which communicate with the branch pipes *c* just above the cocks *e*, and which are provided with regulating-cocks *i*. J designates small pipes, which communicate with the pipes *c* opposite the lower termini of the oil-supply pipes *k*. Pipes J are provided with cocks *n*, and supply coal-gas to retorts A. They communicate with a gas-tank. K, stand-pipes, which are water-sealed in trunk L, and which communicate with retorts A. These pipes *k* carry off the gas for consumption.

When the retorts are properly heated, steam from the boiler B is admitted into them. The oil-supply cocks are then opened, when the steam current will compel the oil to flow into the retorts through the nozzles *g*. The gas-cocks are then opened, and a supply of coal-gas is carried along into the retort.

I thus effect a mixture of hydrocarbon fluid, steam, and coal-gas in the lower ends of the branch pipes *c*, and forcibly inject



IMPROVEMENT IN THE MANUFACTURE OF GAS.

this mixture, in the form of spray, into the retort, where it instantly flashes into a chemically-fixed gas.

The reservoir C is provided with a coil of pipe leading from the steam-generator B. I may thus use in reservoir C rosin, tallow, and other solid matters containing carbon.

A VERY rich deposit of gold has been struck in the Centennial Lode, near Laramie City, Wyoming. At a depth of 100 feet, a large body of quartz has been found, showing an amount of free gold which, it is believed, exceeds any thing ever before seen in rock. A large solid piece of this rock will be sent to the Centennial Exhibition.

IMPROVED FURNACES FOR TEMPERING STEEL.

By J. B. ARMSTRONG, Guelph, Canada.

THE invention has a double application in the art of heating steel for tempering: first, heating the steel uniformly to a stated degree before hardening in oil or any of the usual liquids; second, drawing or "letting down" the temper of steel after hardening, in the usual way, to a uniform degree.

Fig. 1, longitudinal section. Fig. 2, cross-section.

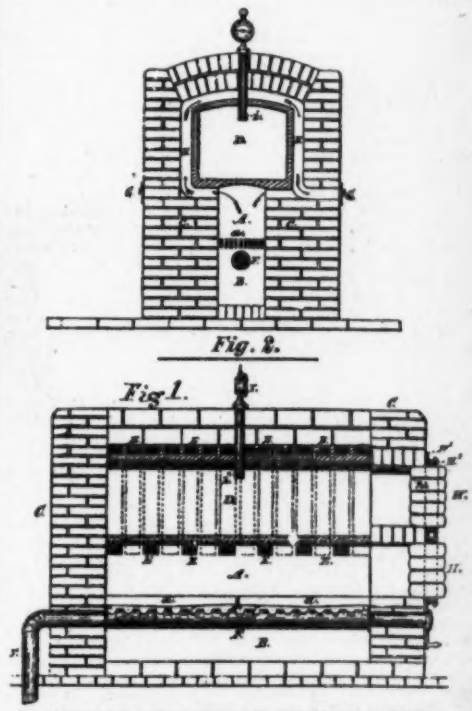
A, furnace, of brick; *a*, the usual grate. Over the furnace, the close retort D is placed, the bottom of the retort forming the roof of the furnace.

The walls, roof, and floor of the retort are constructed of fire-clay, fire-brick, or other suitable material, when the retort is used for heating the steel to harden; but when the furnace is to be used only for drawing the temper after hardening, a cast or wrought iron retort may be used, as a less degree of heat is required than in the former process.

E are flues, which take the flame, heated gases, etc., from the upper part of the furnace up one side, over the top, and down the other side of the retort, the heated gases, smoke, etc., escaping through suitable passages to a common vent. The flues E are narrow passages formed along the whole length of the retort, the intervening walls being thin partitions of fire-clay or cast iron.

The flues are so arranged that they take the draught from and deliver it at alternate sides of the furnace, thus equalizing the distribution of the heat over the whole surface of the retort.

F, blast-pipe, beneath and extending under the whole length of the furnace, the upper surface being perforated with holes *f*, of any convenient diameter, placed at a regular distance apart throughout the entire length under the furnace. Fitting within the pipe F is an inner revolving tube or damper, perforated with holes, at the same distance apart longitudinally as those in the outer tube, the only difference being that the holes are elongated in a transverse direction, and are cut to form a spiral on the inner tube.



IMPROVED FURNACES FOR TEMPERING STEEL.

The object is to enable the operator to vary the position of the delivery of the blast, in order to equalize the heat in the furnace and retort. Thus he may give an equal distribution of the blast throughout the entire length of the furnace, or he may cut it off partially or entirely at one end, throwing the whole blast into the other end, or *vice versa*.

H H, furnace-doors hinged to frames H^1.

The doors consist of an open frame, of iron, H^2, filled in with fire-bricks *h*, the bricks fitting, when the door is closed, within the opening left in the brick-work. Thus no portion of the iron door or frame is exposed to the action of the heat. As the fire-bricks are burned away, they are pushed forwards again and again until consumed, when new bricks are inserted, as before.

I is a pyrometer, of the usual construction, fitted to the top of the retort in such a way that the expanding bar extends downward into the interior of the retort within an open guard-tube, *i*.

Suppose that the retort is charged with single-plate cast-steel carriage-springs. The operator watches the pyrometer, and, by manipulating the blast and blast-discharge, he is enabled to bring the whole of the contents up to without exceeding the proper degree of heat. Of course the thinner portion of the plates reaches that degree first; but they can go no higher than the degree indicated on the pyrometer, waiting, as it were, until the thicker portion has been thoroughly permeated, and the whole mass is in one uniform heat, when the springs are taken out and dipped.

In lowering or letting down the temper after hardening, the same operation is repeated, the operator knowing the particular degrees of heat which correspond to different tempers and working accordingly.

The advantages gained by my invention are: first, that steel of regular and irregular shapes and thicknesses can be raised to (without any portion being allowed to exceed) a uniform degree of heat in tempering; second, that the blast to the furnace can be applied equally or unequally during its whole length to suit circumstances; third, that by the application of the pyrometer the operator is enabled to gauge the heat in the retort, raising or lowering the temperature of the furnace accordingly, and, knowing the degrees of heat which give to steel certain tempers, he is enabled to turn out every charge to a known and exact temper.

Scientific American Supplement.

No. 13.

FOR THE WEEK ENDING MARCH 25, 1876.

PUBLISHED WEEKLY,

AT THE

OFFICE OF THE SCIENTIFIC AMERICAN,

No. 37 Park Row, New-York.

MUNN & CO., Editors and Proprietors.

O. D. MUNN. A. E. BEACH.

The Scientific American Supplement is uniform in size with the *Scientific American*. Terms of subscription for Supplement, $5.00 a year, postage paid, to subscribers. Single copies, 10 cents. Sold by all newsdealers throughout the country.

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AWARDS AT THE CENTENNIAL

By Richard H. Buel.

It is generally admitted by those who have looked into the matter that the system of bestowing awards at public exhibitions is susceptible of great improvement. The system almost invariably pursued at State and county, as well as at international expositions, may be briefly described as follows:

Different classes of awards are fixed upon, such as gold medals, silver medals, and diplomas, each to be awarded for exhibits of a certain class or character, and judges are chosen usually from the best available material, who proceed to distribute these awards, after having examined the competing articles. There are various details, such as organization of the juries, conditions for special awards, checks against neglect or partiality on the part of the judges, facilities for appeals and reviews, and the like; but in general, all systems of award resemble each other in the important particular that the distribution is mainly effected according to the judgment of the jurors, who proceed by no fixed rule. The results of this course of action are far from satisfactory in any point of view. This may be illustrated by the narration of one of the many incidents that have been brought to the notice of the writer. A certain patent governor, on exhibition at a Fair of the American Institute, was deemed worthy of the highest award in its class, a silver medal, as being, in the opinion of the jurors, not only the best instrument on exhibition, but the best in common use; while another competing governor, which may be called No. 2, did not appear to have sufficient merit to be even favorably noticed by the jury. It happened, however, that at the Cincinnati Exposition, held in the same year, where both these governors were entered for competition, an exceedingly careful test was made of all the competing governors, and it appeared, as a matter of fact, that governor No. 2 not only excelled the one which had been awarded a silver medal by the New-York jury, but was by far the best governor on exhibition. Numerous other instances of a similar character could be related, and they seem to show conclusively that a general system of awards in which such things are possible is exceedingly faulty, while they also point the way to a better system, which would render it impossible for juries of able men in different localities to give such contrary decisions. It is evident, for example, that an experienced engineer could readily draw up a table which should detail the features of the most perfect steam-engine governor that could be constructed, and could assign values or marks, with a considerable degree of accuracy, to each of these features. This table would serve as a standard, by the aid of which a jury would proceed to weigh the merits of competing governors, and while, of course, the relative mark awarded to each governor would depend, in some respects, such as finish and design, upon individual judgment, it is evident that the most important details, such as sensitiveness and power, which details would necessarily have the largest marks, could only be decided by experiment. It would seem, therefore, that a jury of experts, in any locality, following the standard table, in their examination of governors, would render essentially the same report upon similar governors wherever exhibited. What is true of governors is equally applicable to any class of exhibits. Thus, it would be possible for experts to draw up standards for the examination of competing pianos, sewing-machines, pumps, or, in fact, of any articles in common use, which articles form the largest and most important part of all exhibitions. Such a revolution in the system of awards, which seems well worthy of trial, could hardly hope for general recognition, unless adopted at an international exposition of world-wide fame. A chance is offered for the introduction of this new system in our own Centennial under more favorable circumstances than have ever before occurred. At this coming exposition, in which each juror is to receive remuneration for his services, it is reasonable to suppose that more careful work will be the result; and the substitution of reports for medals is of itself a great improvement over the methods pursued at previous international celebrations. It is easy to see that if, in addition to these favorable features, each class of reports is made up in accordance with a well-devised standard, the resulting papers will be the most complete and valuable that have ever appeared. It is impossible, in the limits of a popular article, to do full justice to the subject, but there are some considerations that may be briefly noticed.

An international exposition is intended to give a fair representation of the best specimens of the world's work, which shall not only prove valuable and interesting to visitors, but will also be of permanent benefit to the cause of civilization. How well preceding exhibitions have played their part in this respect, need not here be enlarged upon. But referring to any of the former exhibitions of the industry of all nations, as viewed by the reports which record their history, the careful observer can not fail to be impressed with the fact that they have all fallen far short of realizing the highest aims. To illustrate this point more fully, it may be profitable to examine a single phase of the work of a local association, the Royal Agricultural Society of England. Many years ago, this society, which holds yearly exhibitions, instituted a system of awards for portable engines, strictly in accordance with the plan here proposed—laying down certain carefully selected principles (which have been used with little modification to the present time), which were to be applied to all competing engines. The result of this action has been most gratifying, and it is both interesting and instructive to observe the steady improvement of these engines from year to year, until to-day the English agricultural engine may be regarded as among the most perfect of its class in the world. This is not the place to celebrate the praises of the Royal Agricultural Society, and show the many ways in which it has aided the development of agricultural machinery in England, but the single instance cited above is most suggestive. Suppose that at the first World's Fair, a comprehensive scheme had been devised, by which the development of the world's work as there represented had been accurately tabulated, with its good and bad points clearly defined; suppose that what the Royal Agricultural Society has yearly done for the portable engines of a single country, had been extended to the engines, the boilers, the locomotives, the sewing-machines, the furniture, the textile fabrics, the machine-tools, and all the exhibits of the world: who can doubt that, if this system, which might possibly have been somewhat crude at first, had been applied (and extended, if necessary) at each succeeding international exhibition, the beneficial effects of these celebrations would have been largely increased? Perhaps a more striking instance even than that of the English portable engine, cited above, may be found in Mr. Waring's instructive papers on the islands of Jersey and Guernsey. As is well known, the cattle of these islands have a world-wide excellence, which is the direct result of the yearly competitive exhibitions, in which the premiums are awarded for cattle having the greatest number of "points," which have been fixed by skilful experts. Indeed, it needs no argument to show, that if a manufacturer understands that his exhibits are to be severely judged in regard to their approximation to a fixed standard, and that the results of this examination are to be laid before the eyes of the civilized world, one of the strongest possible inducements is held out to him to produce excellent work. It is also equally clear, that no more instructive lesson can be given to an unsuccessful exhibitor, than to point out plainly, as these examinations can not fail to do, the precise features in which his exhibit is defective. An incidental advantage of the system here proposed consists in the facilities for giving the general features of the jury reports to the public. A large portion of these reports being made up of technical descriptions and discussions, is accessible ordinarily to only a few persons who are well versed in such matters. But if a leading feature were the comparison of exhibits with the fixed standards, it is probable that the intelligent correspondents who will be well represented at our exposition would gladly embrace the opportunity to describe the results of these comparisons in their letters.

In any event, the Centennial, whose success is now so well assured, should be of great benefit to our country. It is worthy of consideration whether those who have charge of the awards will not do well to inaugurate a plan which would probably increase the resulting benefits in large degree. It would be an assumption on the part of the writer to volunteer a detailed description of the scheme. Indeed, it would probably require the services of skilful experts in every department, under the guidance of a thorough organizer, to prepare a plan which promises such magnificent results. It is hoped that one of the chief results of our exhibition will be to extend the market for native exhibits, and thus stimulate production—and our manufacturers generally seem eager to compete with the producers of foreign lands. It is difficult to imagine any system of awards that would make the competition fairer and more severe than the one outlined above.

OUT-DOOR ART.

Among the outside attractions of the Exhibition, a prominent place must be given to the statues and statuary groups which will ornament the grounds.

First in the order of time and national interest, we must rank the colossal statue of Columbus, for which the Centennial is indebted to a number of patriotic Italians in Philadelphia. The design represents the great discoverer standing, the right hand resting on a globe, the left holding a chart. At the foot are an anchor and a pulley-block, significant of his calling. The pedestal is inscribed with the great sailor's name and bas-reliefs of his landing. The American and Italian coats-of-arms indicate the work of his life and the spirit of amity between the countries in which the work has been conceived and approved. The figure is of heroic size, 9 ft. high, executed in Ravozzioni marble. It will stand near the Conservatory, at the intersection of Fountain and Belmont avenues. It is intended that the ceremony of unveiling will take place on the Fourth of July.

Next in historical order comes the statute of William Penn, an appropriate monument to the founder of the city, whose principles of peace and good-will to all will be so signally honored in the great gathering of all nations at the City of Brotherly Love. The statue is intended for the dome of the new City Hall, but will first be displayed in a commanding position in the park during the Centennial celebration. It will be the largest bronze casting undertaken in America, and exceeded but by two in the world. The model has been executed by Bailey, the sculptor of the Witherspoon statue.

This monument, to the only clergyman among the signers of the Declaration of Independence, will also be of bronze, and cast at the foundry of Robert Wood. It is the contribution of the Presbyterians of the country. The figure is about twelve and a half feet high, and represents the venerable doctor in oratorical attitude, as in the act of delivering his speech on the Declaration. The costume is the citizens' dress of colonial times, over which is thrown a Geneva cloak. The cost of the monument will be about $25,000. The unveiling will take place some time in May.

The scientific spirit of the age—the spirit of intellectual liberty—will be represented by a statue of Humboldt, also of bronze. The model is by Professor Drake, of Berlin, who has already wrought several busts and statues of Humboldt, with whom he was long intimate. The statue is to be nine feet high, and to cost $13,000.

A still more colossal monument in bronze will be the American soldier, eighteen feet high, by Bartholdi, the design of which has not been given to the public.

The most ambitious of the groups of statuary is that of the Centennial Fountain, to be erected by the Catholic Total Abstinence Union, at the foot of George's Hill, in the rear of Machinery Hall. The basin of the fountain is circular, and ninety feet in diameter. The central figure represents Moses in the act of smiting the rock, the water falling into the basin below. The rock is fifteen feet high, and the figure of Moses which surmounts the rock is of equal height. The pavement surrounding the fountain is raised so as to make the height of the main structure thirty-five feet. Around the main fountain are four subordinate structures, each twenty-one feet high, including statues of Father Mathew, Archbishop Carroll of Revolutionary memory, Charles Carroll of Carrollton, one of the signers, and Commodore John Barry, the father of the American Navy, each nine feet high. The base is of Maryland marble and granite, the figures of Tyrolese marble. The sculptor, Herman Kern, a native of Philadelphia, has been engaged on the work for two years. The Commodore Barry is now finished. Around the circular basin will be seven medallion heads in marble, of the following Catholic generals and civilians of the Revolution, namely, Lafayette, Mme. Lafayette, Comte de Grasse, Count Pulaski, Col. Stephen Moylan, Thomas Fritzsimmons, and Kosciusko. The cost of the monument will be $50,000.

Next in order comes the group of statuary emblematic of Religious Liberty, contributed by the Independent Order of B'nai Berith. The pedestal and marble statue stand twenty feet high. The main figure typifies the Genius of Liberty, a powerful and majestic female figure eight feet in height. The posture is upright, with one knee slightly bent and the foot advanced. The head is covered with the Phrygian cap bordered with thirteen stars. A mantle fastened at the neck falls from the left shoulder to the foot. The right breast and arm are uncovered, the arm extended. The left hand holds the Constitution, and is supported by the bound staves of the States. At the base the American eagle buries its talons in the conquered spirit of intolerance, represented by a serpent. The outspread right hand protects a youthful figure, slightly draped, representing Religion, holding in upraised hands an urn from which rises the eternal flame. The whole is emblematic of religious toleration protected by Liberty. The pedestal will be inscribed with appropriate sentences from the Constitution of the United States. The work is by the Hebrew sculptor Ezekiel, a native of Richmond, Va. The cost is to be $30,000.

There will be besides a marble group of colossal size by Harriet Hosmer, in which a female figure representing Freedom lifts a child from the earth, indicative of Emancipation; and a marble fountain by Foley, with four figures twelve feet high, details of which have not been published.

PROCEEDINGS OF SOCIETIES.

Musical Association. London, February 7.

KETTLEDRUMS.

A. Chappell, Esq., in the Chair.—Mr. Victor de Pontigny read a paper on kettledrums. Kettledrums are the only really musical instruments of the drum family; their note is given by a membrane stretched uniformly over the "kettle," which is generally a metal hemisphere. The note is primarily that of the membrane, but is no doubt modified by the vibrations of the "kettle" in a manner which is not understood. An investigation of the theory is desired, as it may assist to determine the best forms of the "kettle" and the most advantageous conditions of the instrument generally. The range within which each drum can be tuned is a fifth, and the proper compass for the pair is F up to tenor *c*, and B♭ up to *f*. It was considered that the diameters are inversely as the square roots of the vibration numbers (?); the two drums of a pair are consequently as $\sqrt{3} : \sqrt{4}$, or about 26 : 30. The largest admissible diameter is 29 inches. If the drums are too large, inversion of some of the intervals written has to be resorted to, which spoils the effect. A tension of 37 cwt. produced the octave to the note given by by a tension of 11 cwt. The point at which the surface is struck must not be the centre; a better tone is obtained at a point one third of the diameter from the circumference.

Dr. Stone observed that there existed no theory and no literature on the subject.* He thought it desirable that the influence of the "kettle" on the tone should be ascertained; and that these instruments should be employed for the production of tone of 16-foot pitch.

ORCHESTRAL SCORES.

Professor Monk then read a paper "On some points in the arrangement of an Orchestral Score." The paper consisted of the detailed advocacy of an important suggestion, which has been and is in the minds of many musicians, namely, that the notes intended to be played by transposing instruments should be printed in scores according to their actual sounds, and not according to the fingering of the performer as at present. The case of the clarionet was taken as typical, and explained in detail. The part for the performer must be arranged as at present, but there seems to be no reason why these transposed forms should find their way into the score.

The adoption of this suggestion will throw open orchestral scores to amateurs, with the exception of the small portion usually written in the old C clefs. As to these latter, the retention of the tenor and alto clefs was advocated; but the old soprano clef was given up, as being practically obsolete.

Mr. Manns then explained at some length the difficulty which compelled the clarionet-player to play from transposed parts; Mr. Osborne, Mr. Cummings, Dr. Verrinder, and Mr. Stephens spoke in approval of the suggestion made, and in advocacy of the retention of the old C clefs; and a communication was read from Mr. Parratt, in which, in addition to the above suggestion, it was proposed to employ colors for the purpose of distinguishing the portions of the score belonging to the different families of instruments.

Royal Astronomical Society. February 11.

At the annual general meeting, the report of the Council, extending to about one hundred pages, and composed chiefly of short biographical notices, reports from observatories, and notes on the progress of astronomy in the past year, was presented and extracts from it read. Among the obituaries were notices of Mr. Carrington, Mr. Vignoles, Prof. Selwyn, Prof. Argelander, Dr. d'Arrest and M. Mathieu, all of whom died during the past year at an advanced age. It was announced that the gold medal had been awarded to M. Le Verrier for his researches on the theory of the motions of the four superior planets; and the President (Prof. Adams) then proceeded in his address to give a masterly abstract of the labors of the French astronomer, who was unfortunately not able to be present on this occasion.

LE VERRIER'S THEORY.

Prof. Adams commenced by giving a review of M. Le Verrier's theory of the four inferior planets—the motion of the earth being the most important as affecting the apparent motions of all the others—and explained how the discordances between theory and observation in the case of Mars, which could only be accounted for by an increase in the secular motion of the perihelion, had led to the conclusion that Encke's estimate of the sun's distance was too great, an inference supported by other considerations, and now known to be correct, while similar discordances in the case of mercury have been referred to

* See, however, a memoir of Poisson in *Mémoires de l'Institut* for 1812, in which the case of drums is discussed. Also Lagrange, *Mécanique Analytique*. According to the theory the vibration number would be inversely as the diameter, and directly as the square root of the tension.

the perturbing effect of one or more hitherto undiscovered interior planets, or to a ring of such small bodies. Though this work was one of great magnitude, requiring first the formation of the theory and then the discussion of all available observations and their comparison with theory, it did not involve the peculiar difficulties which are found in the motions of the four outer planets, and which Prof. Adams in the course of his address proceeded to point out. Three causes contribute to this result: (1) the large masses of the disturbing planets; (2) the near commensurability of their periods, giving rise to long inequalities; and (3) the necessity for taking account of the second and higher orders of the disturbing force, or, in other words, for carrying the calculation of the perturbations to a second and third approximation, the planets being disturbed so much from their elliptic motion that it is necessary to take account by successive approximations of this alteration in their relative position in order to calculate the disturbance itself, which, of course, depends on the actual positions, unknown quantities which it is the special object of the investigation to determine. The theories of the outer planets are best considered in pairs, Jupiter and Saturn being taken together by M. Le Verrier, and then Uranus and Neptune. In the case of the former, from the fact that five revolutions of Jupiter are nearly equal to two of Saturn, it follows that similar perturbations will be produced after the lapse of each such cycle, and these effects will consequently accumulate until the recurrence of the small difference between the two nearly equal periods brings the two planets into such relative positions that opposite effects are produced. Similarly two revolutions of Uranus being nearly equal to one of Neptune, a large inequality will be the result, and the treatment of these two cases has naturally proved a formidable difficulty for M. Le Verrier. The accordance between theory and observation for Jupiter is all that could be desired, showing that the total mass of the asteroids is not capable of exerting any sensible effect, but in the case of Saturn there are still some large discordances, which have led M. Le Verrier to undertake an entirely new investigation of the motion, conducting, however, to the same result as before, and the question remains whether theory or observation is in fault. By an extension of his theory to higher powers of the disturbing force, M. Le Verrier has quite recently succeeded in representing Bradley's observations (about 1750) with remarkable exactness; but though there is great difficulty in carrying the investigation to a sufficient degree of approximation, and thus taking account of the multitude of small terms which may by their accumulated effect become sensible, Prof. Adams pointed out that the neglect of such terms could hardly account for such an abrupt change as 9″ in five years, though the observations at Greenwich and Paris agreed in showing it. At the conclusion of the President's address, Sir George Airy complimented him in the name of the meeting on his able review of M. Le Verrier's abstruse researches, a *résumé* which he pronounced to be unequalled among presidential addresses.

The meeting then proceeded to the election of officers and counsel, Dr. Huggins being appointed the new President.

[Academy.]

SCIENCE NOTES.

PHYSICS.

The Distribution of Magnetism in the Interior of Magnets.—In a recent number of the *Comptes Rendus* (tom. lxxxi. p. 1123), there is a paper by MM. Trève and Durassier on this subject, the experiments having been made on certain steels of Creusot which contained known amounts of carbon. The steel cylinders, after being magnetized to saturation, were immersed in dilute sulphuric acid, and their weights, diameters, and magnetic moments measured every forty-eight hours. The authors concluded, from their experiments, that the magnetic moment of a magnet is proportional to its weight within certain limits. They observed also that the neutral part of a magnet, at and near its centre, is more corroded by the acid than its terminal portions, and argued that the *magnetism* resists the action of the acid. M. Jamin, in a note appended to this paper, points out that he had previously made the experiment of the solution of a magnet in dilute acid, and combats the conclusions of MM. Trève and Durassier, whom he considers to have underrated the difficulty and complexity of the question. M. Jamin in his researches found that the residue of magnetism in a steel plate which had been submitted to the action of an acid was proportional, not to its weight, but to its cross-section. As regards the unequal corrosion of the steel, it depends exclusively, not upon the magnetism, but on the greater or less hardness of the different parts of the metal.

Solar Isothermal Lines.—In a recent number of the *American Journal of Science*, Prof. Mayer publishes a new method of tracing isothermal lines upon the disk of the sun by throwing the sun's image, formed by the object-glass of a telescope, upon a sheet of paper, smoked on one side and coated on the other side with a solution of the double iodide of copper and mercury. This salt, which is red at low temperatures, has the property of turning black whenever its temperatue reaches about 158° F. If, then, the image of the sun be formed upon such a sheet by an object-glass of considerable size—so capped, however, as to expose but a small portion of its surface—the heat will not be sufficient to discolor the paper at all. On increasing the size of the opening in the cap, more heat will be transmitted, and when the aperture is of just the right size a black spot will make its appearance at or near the centre of the sun's image. With a slightly larger aperture the spot will cover a larger portion of the sun's image, and the outline of the spot will be a true isothermal line on the sun. Trying the experiment with a series of apertures regularly graded in diameter, we should thus obtain a series of isothermals which give us important information as to the distribution of heat on the sun and the absorbing action of the solar atmosphere. Unfortunately, the method is beset with many practical difficulties growing out of the currents of air produced at the heated surface of the paper, and other circumstances not easy to take account of by calculation, so that it is not likely to prove very accurate.

Physical Properties of Matter in the Liquid and Gaseous States.—Dr. Andrews, of Belfast, has, in the last-published part of the Proceedings of the Royal Society, a preliminary notice of his further researches on this subject. The investigation, he informs us, has occupied him with little intermission since his former communication to the Royal Society (in 1869), "On the Continuity of the Liquid and Gaseous States of Matter." Dr. Andrews' researches are of the highest importance and interest, and we look forward to the publication in detail of the methods and results of his various experiments. In the present notice the results given chiefly refer to carbonic-acid gas, when alone or when mixed with hydrogen. The law of Boyle was tested at pressures varying from 13 to 223 atmospheres, the temperatures being in three sets of experiments respectively, 6·7° C., 63·7°, and 100°. The pressures are given in atmospheres as indicated by an air or hydrogen manometer, and it will be necessary hereafter to reduce them to true pressures. At the temperature 63·7°, carbonic-acid gas, under a pressure of 223 atmospheres, was reduced to $\frac{1}{447}$ of its volume under one atmosphere, or to less than one half the volume it ought to occupy if it were a perfect gas and contracted in conformity with Boyle's law. The law of Gay-Lussac, like that of Boyle, was found to be true only under certain limiting conditions. The coefficient of expansion of carbonic acid was shown to change not only with the pressure, but also—when the pressure or volume remained constant—with the temperature. It appears, also, that Dalton's law, which asserts that the particles of one gas possess no repulsive or attractive power with regard to the particles of another gas, entirely fails under high pressures when one of the gases of the mixture is at a temperature not greatly above its critical point.

Influence of Temperature on the Circular Polarization of Quartz.—In Poggendorff's *Annalen* (vol. clvi. p. 424) are given some of the results of Von Lang's researches connected with the transmission of polarized light of various wavelength through plates of quartz, and the influence of change of temperature on the rotational effect when the color of the light varies. The colors employed were three in number, the yellow of sodium, the green of thallium, and the red of lithium, salts of these metals being introduced into the flame of a Bunsen burner, which was placed in front of the apparatus. The latter consisted of a combination of polariscope and spectroscope, and comprised the following parts in order: a Nicol's prism (polarizer), the quartz plate under experiment, a second Nicol (analyzer), collimator tube, and observing telescope. Herr von Lang found that the relative change of the angle of rotation of quartz with change of temperature is the same for all colors, and diminishes as the temperature rises. The temperatures at which the experiments took place were chiefly (1) the atmospheric temperature at the time, about 20° C., and (2) about 94°, obtained by means of steam.

Determination of Verdet's Constant in Absolute Measure.—M. Verdet found in 1853 that when a beam of plane polarized light is passed between the poles of a powerful magnet separated by air or any other medium, the rotation of the plane of polarization is directly proportional to the strength of the magnet, or, in other words, that the ratio between the amount of rotation and the intensity of the magnetic field is constant. The object of an investigation by Mr. J. E. H. Gordon (*Proc. Roy. Soc.*, vol. xxiii. p. 504) has been to measure this constant in absolute units for a standard substance. Distilled water was used, and the magnetic force was produced by means of an electric current in a helix, iron being avoided for the reason that the magnetism of iron magnets is an undetermined function of the shape and nature of the iron core. The main result may be stated in the following form: If plane polarized light passes through distilled water, and the magnetic potential of the water at any two points in the path of the beam differs by unity, then the plane of polarization will be rotated between those points four and a half ten millionths of a unit of circular measure.

The Specific Inductive Capacity of Oil of Turpentine.—At the instance of Professor Helmholtz, Herr O. Silow has conducted some operations with the object of ascertaining whether the formula of Helmholtz, which gives an expression for the force between two quantities of electricity, is susceptible of experimental proof. This formula is $F = A.\frac{EE'}{Dr^2}$, when F is the force of attraction or repulsion between two quantities of electricity E and E′, separated from each other by a distance r, in an insulating medium whose inductive capacity is D, A being a constant. The author devised a modification of Thomson's quadrant electrometer to meet the requirements of his experiments, the ordinary Thomson being unsuitable for the purpose, since it was necessary to surround the quadrants and needle by the fluid whose inductive capacity was under investigation. The only liquid with which experiments appear to have been made was oil of turpentine, and the mean result gave D = 2·221. Hence $\sqrt{D} = 1{\cdot}490$

According to Maxwell's electromagnetic theory of light, the square root of the number representing the specific inductive capacity of a dielectric is equal to its index of refraction for light rays of infinite wave length. Now the indices of refraction of oil of turpentine for Fraunhofer's lines D, b, F, G are 1·468, 1·472, 1·475 and 1·481 respectively, from which it may be calculated that the index of refraction for waves of infinite length is 1·459. The difference between the numbers 1·490 and 1·459, though considerable, is not greater than in similar determinations, by other methods of Boltzmann and Schiller. Herr Silow's paper is in Poggendorff's *Annalen*, vol. clvi. p. 389.

On the Behavior of Amalgams and Fused Alloys when Traversed by a Galvanic Current.—Among the so-called conductors of electricity, that is, that class of bodies which have the property of undergoing no chemical separation of their constituents when a current is passed through them, physicists have been accustomed to include both amalgams and alloys, whether in the solid or fused condition. Gerardin, however, published in 1861 a series of researches (*Comptes Rendus*, vol. liii. p. 727), which went to prove that amalgams and fused alloys, when traversed by a galvanic current, undergo electrolytic decomposition. M. Gerardin found that soft solder, when submitted to the action of a current, is, after cooling, hard and brittle at the positive electrode, soft and malleable at the negative electrode. Quite recently Herr E. Obach (*Pogg. Ann. Ergänzungsband*, vol. vii. p. 280) has made a series of experiments with the view of testing the accuracy and trustworthiness of M. Gerardin's work, and his results are at variance with those of M. Gerardin in almost every particular. They are briefly the following:—(1) The passage of a galvanic current produces no chemical decomposition either in amalgams or in fused alloys; (2) sodium amalgam, after it has been traversed for some time by a current, decomposes water at its two electrodes exactly the same as before the current had passed through it; (3) the action of the current produces no change in the hardness or malleability of tin-lead alloys, nor in the fluid condition of sodium-potassium alloy. It has no effect whatever on the chemical composition of alloys in the neighborhood of the electrodes.

MR. ALBERT, chief of the Machinery Bureau, requests exhibitors of heavy machinery, and especially those resident in the city, to send in such information as will enable him at once to begin to lay the necessary foundations therefor. By an early attention to this request the goods of such exhibitors will be placed in position immediately as received, which should also be as early as possible, thereby avoiding a rush, saving time, and rendering the goods less liable to be injured.

PIG-IRON.

IN a discussion on the shrinkage of pig-iron, before the American Institute of Mining Engineers, Mr. Metcalf said that during the war, from 1860 to 1865, he had charge of the Fort Pitt Foundry at Pittsburgh, where from 10,000 to 15,000 tons of pig-iron were used annually for guns. The limits of density imposed by the government were from 7·24 to 7·28, and if the iron proved to be above 7·30 or below 7·22, the guns could be peremptorily rejected. The nominal minimum limit of tenacity was 30,000 lbs. per square inch. The guns were cooled from the inside on General Rodman's principle, and it was required that when a section of the casting (through the end of the sprue-head) was cut nearly through from the outer circumference, and then broken open by a blow, a crevice should be produced, which should be wider on the outer than on the inner circumference, by an amount not less than 1–10 nor greater than 2–10 of an inch in a 15-inch gun. In order to secure the strongest and most reliable irons for this purpose, he had personally visited the furnaces at Richmond, Mass., the Ringgold furnaces in New-York, and the Ringwood in New-Jersey, the Joanna, in Berks Co., Pa., and also those in the Juniata region and Cumberland Valley. He had, further, investigated the irons from Hanging Rock region, in Ohio, and those from Lake Superior, and from Iron Mountain, Missouri. These various irons, prepared from different ores and fuels, he had found to have very different properties, but he was not prepared to say from what peculiarities of chemical composition the properties resulted. The irons from Richmond, Mass., from Dutchess Co., N.Y., Ringgold, Ringwood, and from the Hanging Rock region, he found of high tenacity, but with a tendency to shrink and crack. The hematite ores of Pennsylvania gave the highest tenacity, but they also were apt to crack. One sample of iron from the Juniata region, taken from an eighty-ton casting, showed a tenacity of 42,560 lbs. per square inch. The ores of Lake Superior gave an iron which we could not use. Some of this iron, made at Vermilion Furnace, near Cleveland, when in the pig, deflected an inch or more before breaking, but when remelted and run in sand, cooled white. Missouri iron, too, even the softest charcoal varieties, chilled ¾-inch on cooling. The hematite irons do not chill well. The irons from magnetic ores were difficult to manage, and were apt to be honeycombed near the trunnions. For general foundry purposes, he had found the charcoal irons from the Hanging Rock region the most suitable, but their tenacity—averaging about 28,000 lbs. to the square inch—was generally 5000 lbs. per square inch less than the hematite irons. The Wassaic irons, from the Amenia ore-beds, Dutchess Co., N.Y., remained soft, even after melting four or five times, and it would carry the addition of 3 to 1 of scrap iron. In shot and shell the government fixed the minimum strength at 25,000 lbs. per square inch. This tenacity could not be obtained from the iron of the Hanging Rock region, even with the addition of Juniata irons, when the melting was effected in a cupola, but when melted in a reverberatory furnace, the desired result was obtained. In general, he had found that the strength of iron melted in a reverberatory furnace was 5000 lbs. greater than when melted in a cupola. The amount of coal necessary for melting in a reverberatory was found to be, on an average for a year, when 11,000 tons were melted, about one quarter ton of coal to ton of iron. In cast-iron columns they had made for the Pittsburgh and Allegheny Bridge, 28 feet 10 inches long, the greatest variation in length was not greater than ¼-inch. This result was attained with irons from Hanging Rock region, but only by careful selection and regular working. Columns ten feet long made of irons taken at random had varied as much as ¾-inch in length. As a rule, the strongest irons showed the greatest strain on cooling, and were hence more liable to crack. And, further, cold short irons were less liable to crack than those that were red short. Again, the temperature of the iron when poured affects the shrinkage—the hotter the metal the greater the shrinkage. Strong gun irons can not be used for small machinery castings. The selection of irons for guns was made from pigs that had been re-melted called iron of second fusion. These pigs were broken and stacked so as to exhibit their fractures from which the suitableness of the iron for guns was judged. A long experience had enabled him, by this means, to select with great closeness irons giving the proper density when cast in guns.

JAPANESE IRON.

THE blast-furnaces of Japan are small, and of very simple construction, although built on the same principle as those of Europe. The walls are built of fire-proof clay, mixed with a few stones. The blast-furnaces are round, and have an opening at the side, closed by a band of clay; opposite are two other openings, through which comes a strong current of air, driven into the furnace by Chinese bellows worked by men. Before pouring the ore into the furnace they mix it with coal, and subject it to a previous calcination, so as to get rid of its carbonic acid, rock-milk, and sulphur.

The Japanese do not understand puddling as practised in the West; but the principle of their procedure is exactly the same. The fused iron, mixed with a little sand and pieces of iron, is again fused with charcoal in a second furnace, where it is left to cool for several days, until the whole mass has the appearance of fluid.

The Japanese method of making steel is quite different from that practised in Europe. They mix a certain quantity of iron in pigs and iron in bars, cover the mixture with borax, and melt the whole for a week in a small fire-proof crucible. The borax serves to dissolve the impurities in the dross. When the metal is separated from the dross, which floats on the surface, and cooled, it is hammered hard, and alternately plunged into water or oil, after which it is cemented and tempered. The mode of cementing is as follows: the steel, on coming from beneath the hammer, is covered with a mixture composed of clay, cinders, marl, and charcoal-powder. When this plaster is dry, the whole is subjected to a red heat, and the steel is afterwards cooled very slowly in warm water which is allowed to become tepid. Steel thus obtained is not very supple, but extremely hard, because it is not properly tempered or completely freed from its impurities. It would not do for making watch-springs, but is used by the Japanese for swords and sabres which are tempered as many as eleven times, and knives which are tempered four times.—*Le Constructeur.*

[Advertisement.]

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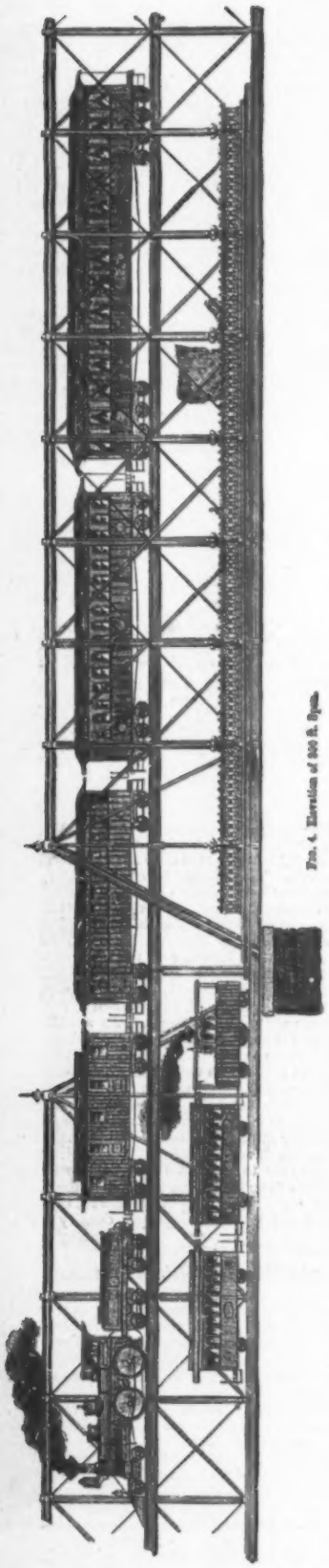


FIG. 1. Elevation of 300 ft. Span.

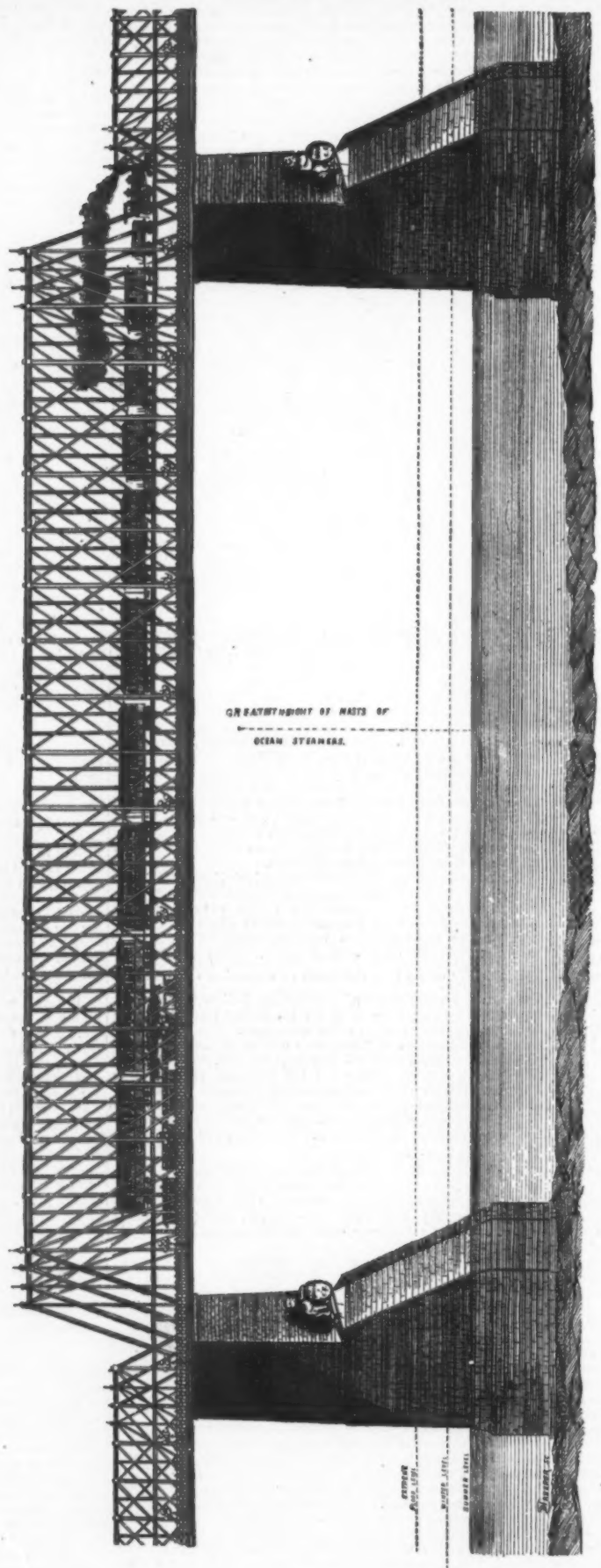


FIG. 2. Elevation of 550 ft. Span.

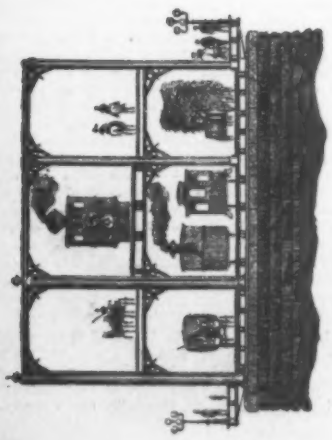


FIG. 4. End Elevation and Section of 300 ft. Span.

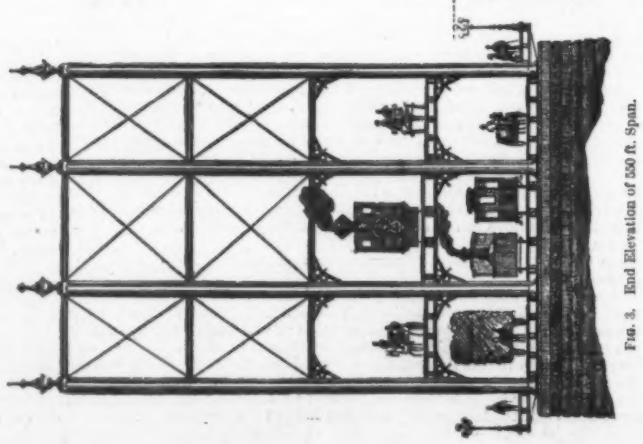


FIG. 3. End Elevation of 550 ft. Span.

I.

IN our Supplement No. 2, January 8th, page 17, we gave a brief account of this great work, designed by Mr. Charles Legge, C.E. We now present engravings thereof, with the following description, for which we are indebted to the *Canadian Illustrated News*.

The impetus which for several years past has been given to the construction of railways on the north of the St. Lawrence and Ottawa Rivers; with a continuation through to the waters of Lake Huron, to tap the lake traffic of the Northwestern States; a more immediate connection by rail of the great lumber districts of the St. Maurice and Ottawa Rivers, including their numerous tributaries, with the leading markets in the United States; the geographical position of Montreal, almost on the air-line; as well as other important considerations to be glanced at, demand a second bridge over the St. Lawrence at this city, in order to effect a union of those Eastern, Northern and Western roads with the great American system on the South, and secure an easy and cheap interchange of traffic.

The Victoria Bridge, while performing the most important function in this interchange of traffic, more strictly speaking accommodates but that of the St. Lawrence Valley with such through freight as it can get. It is a close corporation—in other words, under the entire control of one railway company. It is not too much to say that, in a decade or two, its capacity will be tested to the utmost to accommodate the traffic of the Grand Trunk Railway alone. Even were its carrying capacity much greater, and in a position to be made use of by all railways on the same terms, the difficulty of access to it by the Quebec, Montreal, Ottawa, and Occidental Railway, coming in at the eastern end of the city, would be almost insuperable.

It may be of interest to state that the point of crossing now determined on is nearly identical with the one pointed out many years ago for the Victoria Bridge, when it was proposed to pass the river by a span of then unheard-of dimensions, from St. Helen's Island to a point east of the Market Place, and thence by arches northward to Côte à Barron.

The idea of that day is now being realized in the proposed Royal Albert Bridge, a fit mate for its royal consort, a couple of miles farther up the river.

In combination with its railway traffic, it has also been thought desirable to accommodate that of ordinary character, such as city passenger-cars with dummy-engines, the various descriptions of vehicles, and also afford ample space for pedestrians.

As is well known, for about two months or more each year, this city is cut off entirely from the south shore, whence it derives its principal amount of market supplies, hay, etc.

During this period, prices go up, and the additional money so paid would be no inconsiderable part of the amount required to meet the interest on the cost of the bridge. Ready access would be offered to the south shore night or day, the year round, at a very trifling cost, and at a most expeditious rate of speed, resulting in a few years in the growth of a large city, or "Southern Montreal."

The bridge will also give every required facility for reaching the St. Helen's Island Park, destined to be one of the most pleasant and beautiful of drives or resorts.

The great length of the bridge (about three miles) permits us to give views of but some of its most salient points.

Fig. 1 represents general elevation.

Fig. 2 represents elevation of the 550 ft. span over the navigable channel.

Fig. 3 represents end elevation of 550 ft. span.

Fig. 4 represents end elevation of 300 ft. span.

Fig. 6 represents part end elevation and part section of 300 ft. span.

II.

In connection with these views, the following brief description of the structure is given:

Leaving the level of the ground on the line of Sherbrooke street, it is carried as a viaduct, east of and parallel with Colborne avenue, at a level of ninety feet above the surface of the ground, in spans varying from 150 to 200 feet each. Striking the navigable channel of the River St. Lawrence near Molson's Brewery, it passes over to St. Helen's Island with six spans.

Owing to the angle made by the axis of the bridge with the current, the piers are placed on the skew, so as to be lengthwise in line with the current, and in this manner offer the *minimum* of obstruction; while doing this service, however, it lengthens considerably the superstructure, as, for instance, in the case of the large span of five hundred feet between the masonry, measured at right angles, the length of superstructure span

is increased to five hundred and fifty feet; and so proportionately with the four remaining spans of 300 feet each.

The bottom of the superstructure will be carried level from Sherbrooke street to the centre of St. Helen's Island, there meeting the natural surface of the ground. This will give a clear headway of 130 feet above summer water level in the harbor, or say 120 feet above winter level. (The latter figure is the height of the Britannia Bridge above mean tide level, determined by the British Admiralty as a suitable elevation for navigation purposes.)

Reaching St. Helen's Island, four spans of 240 feet each will carry the bridge to the height of land, where this first section of the structure will terminate.

From the south side of the Island the second section of the bridge will be carried over the unnavigable channel of the St. Lawrence to the south shore by twenty-one spans of two hundred feet each, grading down with an inclination of one foot in one hundred feet. Reaching the south shore, the bridge becomes again a viaduct of five additional spans of two hundred feet each, or until the superstructure has approached within such a distance of the natural surface of the ground as to make embankment more economical; and thence proceeds with ordinary grading to a junction with the Montreal, Portland and Boston Railway, and also the Grand Trunk.

The total length of the bridge and viaduct will be fifteen thousand five hundred feet, or within a fraction of three miles; and the extreme distance covered from the point of departure from the Quebec, Montreal, Ottawa and Occidental Railway on the Mile End heights, to the junction with the line on the south side, will be five and a half miles.

A sufficient length on the natural surface of the ground on St. Helen's Island exists between the two bridges for siding purposes. Trains from opposite directions can thereby cross each other here, and so double the capacity of the bridge.

The piers to be placed in the two channels of the river will be designed on the general principle of those of the Victoria Bridge, for the purpose of allowing the ice to cut freely past.

Those in the navigable channel will be sunk in *caissons*, thereby obviating the use of coffer-dams and other obstructions in the river, and rendering pumping unnecessary. In the south channel the water is very shallow, with a rock bottom, and very little expense will be incurred in putting in the foundations of the piers.

The abutments and piers on the land portion will be of simple design, the first, probably, partaking of the Egyptian style.

The iron superstructure from end to end will be composed of four independent longitudinal ribs, or open lattice girders, placed certain distances apart, and strongly connected laterally.

These ribs will be provided with the usual friction rollers on each alternate pier, to provide for expansion and contraction. Between the two inner girders, on the lower floor, will be a space of eighteen feet to accommodate two tracks for trains of city cars, to be drawn by dummy-engines. Between the two inner girders and outside girders, on either side of the bridge, will be spaces of fourteen feet respectively, for ordinary cart and wagon traffic, passing in one direction on the western, and in the opposite direction on the eastern side of the bridge. Exterior to these two outside girders will be footwalks firmly supported on brackets of iron, strongly attached to the side girders and floor beams; they will each possess a width of 8 feet, and be provided with ornamental railing for the protection of pedestrians.

At a distance of fifteen feet above the lower floor will be placed a second one, strongly connected and braced with iron kelsons and gussets to the longitudinal girders; on this floor between the two inner girders, will be placed a railway-track with crossing arrangements for trains, as before stated, at St. Helen's Island. The spaces existing between the inner and outer girders will each possess the width corresponding to the carriage-ways below, and are intended for carriages and other vehicles requiring a higher rate of speed than carts or wagons. Should a second track ever be required for railway purposes, across the entire length of the river, a fifth girder can be erected on the up-stream side of the bridge, and be supported by iron columns from the saddles of the ice-breakers, at a comparatively small cost.

The entire height of the bridge from the surface of the water will be two hundred and ten feet for the centre span, or two hundred and fifty feet from foundation.

Carriages and carts will have access to or departure from the bridge on the level of Sherbrooke street, and possibly at some suitable points between that street and the river, by means of incline approaches.

Pedestrians or those wishing to take the city cars will also obtain access to the bridge in this manner.

A pretty close estimate of the work may be stated under the following heads:

Masonry	$2,250,000
Iron superstructure	2,250,000
Land purchase and contingencies	500,000
Total cost of bridge	$5,000,000

III.

Fears have been entertained that the introduction of the piers into the water would materially increase the current in the channel; that such fears are groundless will be seen from the following figures. Two lines of soundings were accurately taken, and the velocities of the current ascertained, one crossing Isle Ronde, below St. Helen's Island, the narrowest point in the channel; the second sixteen hundred feet further up the river, and crossing St. Helen's Island. The sectional area of discharge at Isle Ronde was found to be 36,670 square feet, moving with a central surface velocity of 9.2 miles per hour.

Number two, or adopted line, gives a sectional area of 51,448 feet' with a central surface velocity of 6.9 English miles, per hour. If from this sectional area be deducted that required for the piers, 4248 square feet, there will yet remain 47,200 square feet, or 10,530 square feet in excess of the entire channel at Isle Ronde. The increased velocity arising from the obstructing piers will be 0.8 of a mile in 150 feet, or the length of the pier; making a total current for this distance of 7.7 miles per hour, or 1.5 miles less than at Isle Ronde in its present condition. The declivity generated by this obstruction will be but 5½ inches in the length of the pier. From the foregoing, it will be seen that the channel opposite Isle Ronde will be in reality the sticking-point, and not the site selected for the Royal Albert Bridge.

But, apart from all this, the slight addition to the current for so short a distance would have no appreciable effect upon the speed of an ocean or river steamer; while, in the case of ships, the present admirable arrangement of a steam chain-tug made use of by the Harbor Commission, will easily overcome the difficulty. The piers presenting a sharp angular sloping surface, on the up-stream side, to the approaching current, will permit the water to glide past with the least possible disturbance.

The superstructure has been designed for carrying the following live load under a coefficient or factor of safety of 6; in other words, the weight of live load to be presently mentioned, including the weight of the bridge itself, is but one sixth of the ultimate strength or actual breaking-weight of the structure.

1st. A train made up of locomotive-engines, running 30 miles per hour, equal per lineal foot to...2500 lbs.
2d. Two trains of city cars with dummy engines loaded with passengers, going six miles an hour, say.....2500 lbs.
3d. Carriage-ways and foot-walks, loaded at 100 lbs. per square foot.....7500 lbs.

Making a total of 12,500 lbs. per running foot, or, divided into the four girders, will make each one carry, in addition to its own weight, about 3100 lbs. per running foot. Many bridges have already been built carrying even greater live loads.

The following comparison is made between the two rival bridges:

ROYAL ALBERT.	VICTORIA.
1 span, 550 feet skew.	24 spans, 242 feet each.
4 spans, 330 feet skew.	1 span, 330 feet.
4 spans, 240 feet square.	
51 spans, 200 feet square.	
4 approaches, 400 feet each.	
With abutments, piers, etc., making about 15,500 lineal feet of iron superstructure.	With piers, etc., making a little over 7000 lineal feet of iron superstructure.
Greatest clear height above water, 130 feet.	Greatest clear height above water, 60 feet.
Height of centre span above water, 210 feet.	Height of centre span above water, 83 feet.
Greatest depth of water, 40 feet.	Greatest depth of water, 22 feet.
Strength of current, 6.9 miles.	Strength of current, 7 miles.
Estimated cost, $5,000,000.	Actual cost, $6,300,000.

The Victoria Bridge required six years in its erection. It is thought the Royal Albert can be built in three.

IV.

It is proposed that the bridge be under the control of no one railway company, but be free and open to all on equal terms; that the schedule of tolls for crossing shall be determined by directors to be appointed by the different governments and corporations interested in the work, subjected to the supervision, if required, of the Governor in Council.

That as the Dominion Government and that of the Province of Quebec are interested in obtaining a winter outlet for the roads they are now building, to the seaboard and into the neighboring country, for the interchange of traffic, and that as many of the American lines, both East and South, are also deeply interested in passing over this new air-line from Montreal to Lake Huron, and eventually to Saulte Ste. Marie, to join lines in the West, the government and representatives of those railways be invited to assist, by giving guarantees on bonds to be issued.

To the city of Montreal the work will be of almost incalculable value. Some years ago the city contributed $1,000,000 to the M. N. C. R. In return from this, she will get the railway, and the $1,000,000, or more, returned in the Barrack property which the city now owns. Montreal might, under these circumstances, give liberal aid to the bridge, which will add so largely to her prosperity and growth.

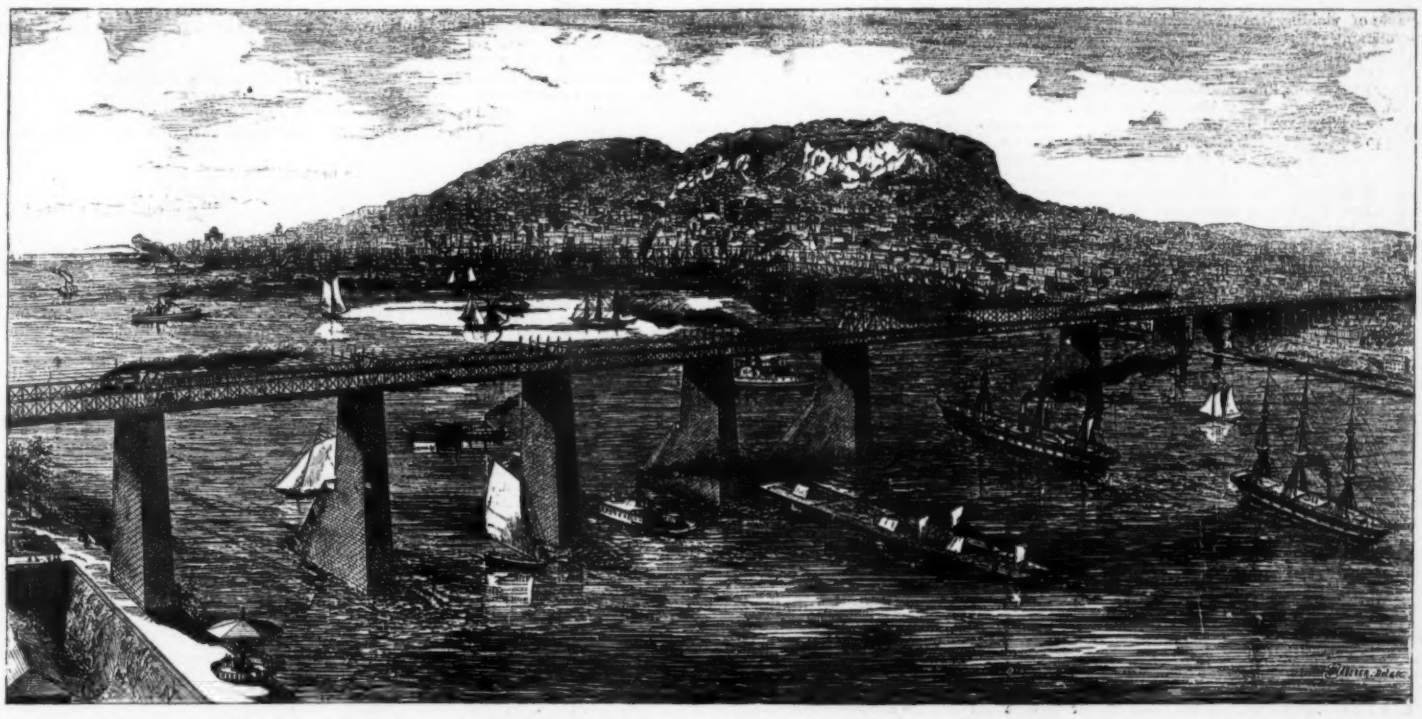


FIG. 1.—THE PROPOSED ROYAL ALBERT BRIDGE, MONTREAL.—DESIGNED BY CHARLES LEGGE, C.E.

THE DAL BRIDGE, SWEDEN.

AT a recent meeting of the Institution of Mechanical Engineers, Birmingham, a paper was read "On the Mode of Erection of the large Iron Girder Railway-Bridge over the River Dal, in Sweden," by Mr. E. Hutchinson, of Bournemouth. This bridge, constructed by the Skerne Ironworks Company, Darlington, is for a single line of railway, and is formed of two side spans of 79 feet each, and a centre span of 208 feet opening; the girders for each of the spans are constructed on the lattice principle, with a double system of bracing. In the erection of this bridge the side spans did not involve any difficulty; but the erection of the centre span presented special difficulties, because it was impossible to get any staging or support between the piers, 208 feet apart, on account of the deep and rapidly flowing stream carrying down large quantities of floating timber during the summer season, and not being frozen sufficiently solid in winter. The plan of rolling the pair of centre girders over the piers was rendered impracticable by their length so greatly exceeding that of the side girders, by which they would have had to be counterbalanced during the operation. The plan ultimately adopted was to put together each half of the centre girders simultaneously from the piers, by erecting them in their permanent position with the work projecting and overhanging as the erection advanced, until the two halves met in the centre of the span. For this purpose, the short girders of the side spans were first erected, and were loaded with a sufficient amount of counterweight to balance the half of the centre girder; the ends of the centre girders were then secured to them by strong ties, and the projecting out of the main girders was commenced. Each portion of these girders was fixed in position in nearly the same form in which it had left the works at Darlington, no further riveting being done until each piece was in position; and the weight of the heaviest piece fixed at one operation did not exceed 25 cwt. As the riveting up of the main girders proceeded, the cross girders, which had been riveted up at the works, were fixed, as well as the rail bearers and such parts of the main bracing as were required to give stability to the work. No special provision in the form of staging for the workmen was made, planks temporarily laid across the transverse bearers or rail girders being found sufficient for the purpose. When the main girders were completed and closed up at the centre, and the temporary ties attaching them to the side girders were removed, there was only a slight and hardly appreciable deflection at the centre of the main span. The bridge was erected during the winter season, the cold being at times so severe that operations had to be entirely suspended. No accident of any kind happened in carrying out the work.

CHEMICAL PRODUCTS AT THE VIENNA EXHIBITION.

A NEW coloring matter, derived from aniline, and discovered between 1869 and 1873, is saffranine. This fine color, now manufactured on a large scale, and much used in silk dyeing, is a very pure and brilliant red, verging upon scarlet. It is a derivative of toluidine, and is prepared by treating heavy aniline oil, boiling between 386° and 397° F, with nitrous acid or nitrites. A mixture of nitrogenized bodies is thus obtained, and is oxidized by means of arsenic acid, bichromate of potash, sulphuric acid, etc. Crude saffranine is purified by taking advantage of its solubility in dilute alkaline liquids. It is now sold as muriate in the form either of a paste or of a crystalline powder. The finest sorts are manufactured by Lotz, Durand, and Huguenin, and Geigy, of Bâle, and Poirier, of Paris.

All the salts of saffranine exhibit the following characteristic reaction, which distinguishes them readily from the salts of rosaniline. If sulphuric acid is added to solutions of saffranine, their red-brown color becomes successively violet, deep blue, deep green, and finally light green; an addition of water gradually changes the colors in the opposite order. Magenta, on the contrary, is turned yellow by sulphuric acid, and water restores the red shade.

Among the number of aniline colors, we may further mention the following: Phosphine (doubtless a salt of chrysaniline or chrysotoluidine), which dyes a fine orange; palatine orange, prunine brown, induline, Coupier's blue. This last, prepared apparently from the residues of the manufacture of blue, finds a very extended use in wool-dyeing as a substitute for indigo.

Kopp and Gnehm have prepared a splendid orange coloring matter, hexanitrediphenylamine, by the action of concentrated nitric acid upon methyl diphenylamine, and still better upon diphenylamine. It forms very fine crystalline salts, soluble in water and ammonia. Its soda and potash salts dye silk and wool fine reddish-orange shades, very brilliant, and possessing a certain dichroism. The preparation and use of this coloring matter are rendered very difficult, in consequence of its violent blistering action.

(*b*) *Naphthaline Colors.*—Naphthaline and its derivatives are capable of yielding many dyes, but few of them have been permanently introduced into commerce; these are the brown, the violet, and the naphthylamine garnet of Courtois, the yellow of Martius, and naphthaline rose, or Magdala rose. The yellow of Martius, known also as naphthylamine yellow, or Manchester yellow, and sometimes incorrectly called aniline yellow, may be prepared by different methods. It is made according to Martius, by the action of nitric acid upon azodi, naphthyldiamine, a product of the reaction of nitrite of potassa, soda, or lime upon the muriate of naphthylamine; or, according to Ballo, by the direct action of nitric acid upon naphthylamine, or, lastly, according to Darmstædler and Wichelhaus, by nitrating the naphthol prepared by means of naphthylsulphurous acid or sulphonaphthalic acid. It is one of the finest and most solid yellows which we possess, and dyes wool and silk without mordant, all shades, from the lightest lemon to a gold-yellow. It is chiefly used for dyeing wool and leather, and for printing woollens and carpets.

The fine rose color known as Magdala red, manufactured and exhibited at Vienna by MM. Duran and Huguenin, of Bâle, is the product of the reaction of azodinaphthyldiamine. It may be prepared as follows: heat on the sandbath, in a vessel of enamelled cast-iron, a mixture of

Azodinaphthyldiamine	6 parts,
Naphthylamine	9 parts,
Glacial acetic acid	5 parts,

raising the heat gradually to 402°, until the red mass takes a violet tint on its upper edges. Remove the fire, add three to four tenths of glacial acetic acid, stirring well, and pour the mixture into enamelled capsules. The crude matter thus obtained, containing acetate of naphthylamine, is transferred into a retort; caustic soda and water are added, and the mixture is boiled until all the naphthylamine has distilled over with the vapor of water. The residue is then slightly acidulated with hydrochloric acid, diluted with much water, filtered whilst hot, and the filtrate mixed with common salt. On cooling, Magdala red falls as a muriate in the form of a crystalline powder. By redissolving in boiling water containing a little muriatic acid filtering, neutralizing the filtrate with carbonate of soda, and treating with common salt, the coloring matter is obtained almost absolutely pure.

The alcoholic solution of this salt displays a splendid dichroism. When dilute it appears transparent and rose-colored by transmitted light, but by reflected light opaque and of a fiery red. This singular fluorescence is communicated to silk dyed with this color, which appears of a carthamine rose with orange reflections. Magdala rose is only used for light shades; in heavy shades it is deficient in brilliance. It has a tinctorial power equal to that of the aniline colors, and it resists air and light much better, for shades of the same intensity.

(*c*) *Phenol Colors.*—The Vienna Exhibition did not bring forward any new phenol colors; on the contrary, some formerly found in the market have been withdrawn, being superseded by aniline colors more beautiful or cheaper. Thus the picramate and isopurpurate of potash and azuline are no longer in use. Large quantities of picric acid are still made and consumed; also of aurine or rosolic acid, and of red, orange, and yellow coralline. As novelties we may mention the splendid coralline lakes exhibited by Guinon and Piccard, of Lyons. The magnesia-lake, the color of which resembles Turkey-red, is much used; but its permanence is not equal to its beauty. During the last year the "Baden Aniline Works," at Mannheim, have sent out a beautiful red color, eosine, which will probably have a great future in dyeing.

TABLE OF THE CHIEF ARTIFICIAL COLORING MATTERS NOW IN THE MARKET.

Reds.—Magentas, about twelve sorts; cerise, three sorts; coralline and aurine, three sorts; saffranine, scarlet, Magdala red, garnet, peonine, Coupier's red, eosine.

Violet.—Magenta violets (mono- or di-phenylated rosanilines), seven sorts; twelve to fourteen sorts of dimethylaniline violets, all soluble in water; mauveine.

Blue.—Nine or ten sorts of aniline blue (triphenylrosaniline); Nicholson blue, imperial blue, light blue, soluble in water or alcohol; induline, Coupier's blue, diphenylamine blue and methyldiphenylamine blue.

Green.—Six or seven sorts of iodine green; four or five sorts of methyl green; aldehyde green.

Yellow.—Aniline yellow, phosphine, palatine orange, picric acid, Martin's yellow, naphthaline yellow, coralline.

Brown.—Vesuvine, Bismarck, Havana, prunine, Manchester, naphthylamine brown, maroon phenicienne.

Grey and Black.—Silver grey and aniline black.—*Prof. Kopp, Moniteur Scientifique.*

MISCELLANEOUS CHEMICAL NOTES.

By S. DANA HAYES, STATE ASSAYER OF MASSACHUSETTS.

WITHIN little more than a year, there have been several cases of poisoning in the State of New-Hampshire, and three of them, which resulted fatally, were, after complete investigations, made the subject of well-contested trials, that have attracted general attention in New-England. There are features of interest to the toxicologist in each of these cases, and very brief records of them may prove valuable hereafter.

THE MAJOR STRYCHNIA CASE.

Edwin W. Major, of Wilton, twenty-eight years old, was tried twice, in September and December, 1875, for poisoning his wife, and was convicted of murder in the first degree. Mrs. Major died on the 20th of December, 1874, after about two hours' sickness. The characteristic ante-mortem symptoms of poisoning by strychina were well observed—twitchings, convulsions, lucid intervals, rigidity, clenched hands, arched feet, etc., and the post-mortem examination, made one day after death, showed no disease of the vital organs; a full-grown healthy fœtus, remarkable rigidity, arched feet, etc., and these appearances were observed again when the body was exhumed the second time, twenty days after death.

Dr. Edward S. Wood, Professor of Chemistry in the Harvard Medical College, made the analysis of the contents of the stomach and a portion of the liver, by Dragendorff's alkaloid method, and obtained excellent results and specimens for exhibition, which he proved by many chemical tests and by repeated physiological tests. I also tested the strychnia separated by Dr. Wood, and analyzed the stomach itself, after he had removed the contents. This is the first time that the Dragendorff method has been presented in evidence before a jury in this country, I believe, and, as the accuracy of the process was questioned by the counsel for the prisoner during the first trial, a good opportunity for proving it was thus offered. After cutting it fine, I divided this stomach into two portions, as nearly equal as could be determined without weighing, and then separated the alkaloid from one portion by Dragendorff's process, and from the other by the modified Stas process, using only alcohol, acetic acid, chloroform, and potash, and proved it to be strychnia by the usual chemical and physiological tests. These portions of the stomach alone yielded 0.24 and 0.27 grain of strychnia respectively. The semi-fluid contents were estimated, from the part analyzed by Dr. Wood, to contain 1.72 grains, the stomach itself yielded 0.51 grain, and the liver, estimated from the portion analyzed, contained 0.23 grain of absorbed strychnia, the total weight being 2.46 grains in these organs.

Dr. Theodore G. Wormley, the eminent toxicologist, of Columbus, Ohio, testified to the accuracy of the modes of analysis and tests employed, and also as to the properties and characters of strychnia.

The counsel for the prisoner held that Mrs. Major died in puerperal convulsions, and from eating camphor, and they contested every point stoutly and in a most intelligent manner.

This case of circumstantial evidence is remarkable for the accuracy of the observations of the symptoms and post-mortem appearances, for the large quantity of strychnia recovered, for the completeness of the analyses and chemical evidence, and for the singular theory of the defence (puerperal convulsions), which was credited by part of the jury at the first trial.

THE MAGOON STRYCHNIA CASE.

David L. Magoon, of Raymond, sixty-one years old, was tried, in November, for poisoning his wife with strychnia, administered in a dose of essence of peppermint. Mrs. Magoon died on the thirty-first of August, 1874, about an hour after receiving something "bitter" to drink from her husband. There was no evidence given of ante-mortem symptoms, and there was no inspection by a medical man, but the rigidity of the body and clenched hands were observed by persons in attendance. The muscles of the arms were relaxed in fourteen hours.

One year after death, the body was exhumed, and the stomach, about one third of the liver, and one quarter of the intestines, were then removed and brought to me for analysis. These organs were in a remarkably good state of preservation, being entire and quite strong, and the stomach still held nearly one fluidounce of brown-colored, semi-fluid contents.

This unusual state of preservation was attributed to the position of the grave, in a dry gravel soil. The analyses were made by Dragendorff's method, and the alkaloid obtained was identified by the usual eighteen or twenty tests, including the administration to frogs. Part of the strychnia separated, with the portion of the intestines as received, was handed to Dr. Edward S. Wood, and he corroborated my work by determining the presence of traces of strychnia in the intestines, and by proving the alkaloid that I had separated from the other organs.

The stomach and contents afforded 0.15 grain, and the liver, estimated from the one third part analyzed, contained 0.684 grain of absorbed strychnia, the total weight being 0.834 grain in these organs, with traces in the intestines.

The prisoner was very well defended, and, after the usual legal doubts about chemical analysis had been presented, the theory of suicide was advanced, and so well supported, that, although the jury agreed that death resulted from poisoning by strychnia, four of them doubted the prisoner's guilt. Magoon is now in jail, and will be tried again in April probably.

This case is remarkable, inasmuch as strychnia in considerable quantity was found in the body a year and six days after death, and for the large proportion of the alkaloid recovered from the liver.

THE WILSON ARSENIC CASE.

Mrs. Sarah M. Wilson, a domestic, over fifty years of age, was tried for poisoning three members of a highly respected family in Lebanon, last April, by putting arsenious acid into the teapot. Two of the persons who drank the tea, a lady and a gentleman, recovered after excessive vomiting and purging; but the third, an elderly lady, died about forty hours afterward, with characteristic symptoms. The medical part of the investigation of this case, including the observation of the symptoms and the post-mortem examination made soon after death, was uncommonly complete, and there was an abundance of carefully preserved material for analysis.

One fluidounce of the tea, mixed with milk and sugar, as left in one of the cups, contained 2¼ grains of arsenious acid, and the cups held nearly eight ounces. The moist leaves in the pot from which the tea was taken had more than 2 grains adhering to them. The stomach of the deceased lady contained 1.28 grains, the liver 3.86 grains, and the intestines 1.77 grains, making the total weight 6.91 grains of arsenious acid recovered from these organs.

The evidence in this case was carefully prepared, and it was presented at the preliminary trial, and to the grand jury who found Mrs. Wilson to be insane.

Both of the persons who recovered must have taken ten or fifteen grains of arsenious acid in the tea that they drank; and their recovery, together with the full evidence of poisoning, make this an instructive case.

MANUFACTURE OF CREAM OF TARTAR.

By J. W. HAAS, Dubuque, Iowa.

THE argols, after being ground, are placed in a steam-cylinder, the quantity depending on the size of the cylinder—about eleven hundred pounds (1100)—to which are added the requisite equivalents of hydrochloric acid (H Cl) chemically pure, of thirty per cent gravity, and chloride of potassa (K Cl.) The cylinder is filled with water, and closed so as to be steam-tight. Steam is then admitted through a pipe, and permeates the mass.

The following formula expresses the chemical changes and reactions produced, and taking place under a pressure of steam of the requisite degree continued for three (3) hours:

$$2\,C^4H^4\,Ca\,O^6 + 1\,H\,Cl + 1\,K\,Cl = 2\,Ca\,Cl + C^4\,H^4K^2O^6.$$

The steam is then turned off, and the cylinder and contents allowed to remain till the crystallization of the bitartrate of potassa is complete, which usually takes about three (3) days. The mother-water is then drained off through the pipe C into another cylinder, charged as the above, with the addition of water sufficient to fill the same. By this means all undissolved tartrate of lime and uncrystallized bitartrate of potassa are saved and utilized. The crystals of bitartrate of potassa deposited in the cylinder and the insoluble and foreign matter at the bottom can then be removed. This product of bitartrate of potassa is chemically pure. By adding the necessary amount of animal charcoal when the argols are placed in the cylinder, all coloring matter will be removed.

It will be observed that this process differs essentially from those hitherto employed, in that I do not effect the solution of the argols by ordinary boiling, nor by heating by means of a steam-jacket. By either of these methods, which are the only ones now in use, a much longer time is required to effect the solution of the argols, and the requisite chemical changes

DYEING RECIPES.

From Reimann.

EXTRACT BLUE FOR WOOL AND WOOLLEN PIECE-GOODS. (55 lbs.)

Make up the beck with 17½ ozs. sulphate of soda, the same weight of sulphuric acid, and from 7 to 17½ ozs. indigo, carmine according to shade. Boil up, cool and enter, boiling with continual turning till the shade is obtained.

SLATE-GREY, FOR THE SAME MATERIALS. (55 lbs.)

Boil for 45 minutes, with 11 lbs. logwood, 17½ ozs. of sulphate of soda, and 8½ ozs. sulphuric acid. Take out, and dissolve in the beck 8¾ ozs. copperas; re-enter and boil for another half hour. If a very blue tone is wished, top with ammonia.

CINNAMON BROWN ON THE SAME MATERIALS. (55 lbs.)

Boil for 45 minutes with 4 lbs. 6 ozs. fustic, 26 ozs. logwood, 11 lbs. red sanders, 2 lbs. 3 ozs. to 3 lbs 4½ ozs. myrabolans. Take out, and add to the beck 8 lbs. 12 ozs. to 11 lbs. copperas (?) Re-enter, and dye for half an hour at a boil.

DYEING AND FINISHING BLACK LINEN SEWING-THREAD. (11 lbs.)

Wet out in boiling water, and enter in a beck at 212° Fahr., made up of 17½ ozs. solid extract of logwood, and 3½ ozs. solid extract of bark. Work for an hour, lift, and hang out in the air for 12 hours. Return now to the extract beck, which should be at about 88° Fahr., give 8 turns and take out. Work for a quarter of an hour in a fresh cold beck of 6½ ozs. blue vitriol; take out, and dissolve in the old logwood beck 17½ ozs. of soda-ash. Enter, and give 10 turns. Take out, return to the blue vitriol beck, give seven turns. Take out, return to the extract beck, and give seven more turns.

Next, dissolve in the blue vitriol beck 7 ozs. copperas, enter the yarn, give 10 turns, and return to the logwood beck for seven turns. Finally, make up a fresh boiling beck of 8¾ ozs. curd soap, and give seven turns. Oil or glycerine may be added to the soap beck to insure softness.

After drying, the thread is run over cold rollers, being twisted slowly all the time, that it may be flattened in different directions. It is essential that the thread should not be washed or undergo any other treatment after the soap beck.

GREEN ON MIXED GARMENTS. (11 lbs.)

The wool is dyed green by boiling for one hour with 2 lbs. 3 ozs. alum, 8¾ ozs. argol, 4½ ozs. sulphuric acid, 2 lbs. 3 ozs. fustic, and 6½ ozs. extract of indigo. It is then entered in a beck at 190° Fahr., with 17½ ozs. alum and the same weight of fustic. Here the goods are worked for an hour, lifted, wrung out and entered in a fresh beck of 2 lbs. 3 ozs. sumach. Here they are soaked for two hours, turning frequently, lifted, wrung well out, and dyed in a fresh cold beck with methyl green. If the shade has to be darkened, decoction of logwood is added as required.

PONCEAU AND SCARLET WITH SAFFRANINE ON COTTON. (11 lbs.)

Prepare a boiling beck with ¼ kilo. turmeric, and work the goods in it for an hour. Take through a beck of 17½ ozs. sulphuric acid, lift and prepare for three hours at a boil with 2½ lbs. sumach. Take out and dye in a fresh beck at a hand heat with a clear solution of saffranine.

IRON GREY ON SILK YARN. (11 lbs.)

After ungumming, the silk is well washed twice and mordanted cold, with 2 lbs. 3 ozs. nitrate of iron and 17½ ozs. sulphuric acid, for light shades. For mediums, 4 lbs. 6 ozs. nitrate of iron may be taken, and for darker shades 8¾ lbs. Give the silk seven to nine turns in the iron, and wash twice. Then dye with a mixture of logwood, peachwood, and fustic, according to pattern, at 110° Fahr. Wash once.

METHYL GREEN ON WOOL.

Boil the wool for fifteen minutes in a solution of the hyposulphite of soda, containing nearly ¼ oz. of the dry salt to 20¾ ozs. of water. When the wool is perfectly saturated, add to the liquid 31 grains of sulphuric acid. The liquid should look perfectly clear after the wool is removed. The beck employed must not be made of copper, lead, or iron. If the hyposulphite beck is made too concentrated, the wool will be

harsh to handle, and the green dye will look flat. No metallic salt must be present. The wool is then dyed in a clear solution of methyl green in water. For a yellower shade picric acid and acetate of zinc are dissolved in water in the following proportions: ¼ oz. picric acid, 95 grains acetate of zinc, and 13 gallons of water. After dyeing the wool yellow in this mixture, some acetate of soda is added, and the wool is dyed in the solution of ¾ oz. methyl green.

FAST RED WITH ARTIFICIAL ALIZARINE ON WOOLLEN YARN (22 LBS.)

Boil for ninety minutes with 3¼ lbs. sulphate of alumina and 17½ ozs. tartar. Rinse well, and dye with 14 ozs. alizarine paste at 10 per cent, entering the goods in the cold beck, and raising gradually to a boil. If the spent alizarine beck is mixed with 17½ ozs. sulphate of alumina, the same weight of bisulphate of soda, a little fustic, and indigo-carmine residues, a fine mode-brown may be produced.

[Chemical Review.]

PRACTICAL DYEING RECIPES.

Safflower Scarlet, 60 lbs.—Bleach; then boil, until quite dissolved, 3 lbs. of concentrated annatto with 1 lb. soap, 1 lb. common soda; add this to a bath of boiling water. Work yarns one hour, 10 turns, wash in 2 cold waters, and wring up. Add to a bath 1 bottle of safflower carmine, work yarns 4 turns, and lift; then add 6 gills of acetic acid; enter yarns again; work till all the color is taken up, wash off in 3 cold waters; add 1 lb. of cream of tartar in last water, wring and stove. Darker shade by using more wares.

Saffranine Pink, 60 lbs.—Bleach, then mordant in red liquor, No. 4. Wash well from this in two or three cold waters, and wring. Add to a warm water 1 lb. saffranine paste. Work yarns 5 turns. Wash off in cold water, and stove.

A good pink may be dyed with saffranine by putting on a good soap mordant in place of red liquor.

Saffranine Scarlet, 60 lbs.—Bleach; boil 2 lbs. concentrated annatto with 1 lb. soap, 1 lb. soda, until all are well dissolved; add this to a boiling water. Work 10 turns, wash in 2 cold waters, and wring up. Mordant in red liquor, No. 4, wash off in 2 waters, and wring. Add to a beck of warm water 2 lbs. of saffranine. Work yarn in this for 1 hour, 10 turns. Wash off in cold water, and stove.

Analine Scarlet, 60 lbs.—Bleach; boil 3 lbs. of tannic acid. Put yarns down in this over night, using as mordant the tin mordant. Wash off in 2 cold waters, and wring up. Dissolve 6 ozs. of aniline scarlet, add this to a warm water. Work yarns one hour, 10 turns. Wash in cold water, and stove.

Another Scarlet, 60 lbs.—Bleach and mordant; then boil 3 lbs. turmeric, and 3 ozs. of aniline ponceau; add this to a hot water. Work yarns 10 turns, wash in cold water, and stove.

Common Scarlet, 60 lbs.—Bleach; boil 6 lbs. sumach; add this to a hot water. Work yarns 5 turns, and wring; mordant in tin. Wash in two cold waters and wring up. Boil 18 lbs. peach wood, 18 lbs. fustic, ground; add this to a hot water. Work yarns 10 turns, raise with 1 lb. alum. Wash in cold water, and stove.

For lighter shades the sumach may be dispensed with, and turmeric may be used in place of fustic.

Violet on Wool, 55 lbs.—Dissolve 4½ ozs. of methyl violet of the suitable shade in water; add it to the beck, in which, further, 2 lbs. 3 ozs. of sulphate of soda must be dissolved. Boil up, cool, enter the wool, and dye at a brisk boil.

Navy Blue on Cotton Yarn, 11 lbs.—Boil 2 lbs. 3 ozs. St. Domingo logwood, and dissolve in the clear, hot decoction 26 ozs. curd soap. Steep the clean yarn in this liquor for two hours at 167° Fahr. Take out; add to the beck 26 ozs. copperas; re-enter the yarn, and work till the color is even. Wash in cold water, and work in a fresh beck, with 17½ ozs. of curd soap, at 144° Fahr., for an hour. Make up a boiling beck, with 2½ ozs. of an aniline blue soluble in spirit, and 2 lbs. 3 ozs. red liquor, at 10° B. Work the yarn in this at a boil till the shade is obtained, and finally rinse.

ANILINE BLACK.

By M. ANTONY GUYARD.

IF to a normal mixture for aniline black, formed of 100 grms. water, 8 grms. hydrochlorate of aniline, 3.5 to 5 grms. chlorate of potash or soda, there is added about 1 centigramme of vanadious chloride or vanadiate of ammonia, the liquid darkens in a few moments and deposits aniline black in abundance. In about 48 hours the reaction is almost at an end, and the liquid becomes thick, almost solid. This reaction is so delicate that 1 part of vanadious chloride or vanadiate of ammonia can easily convert 1000 parts hydrochlorate of aniline into aniline black, and that in practice 500 parts of an aniline salt are readily turned into aniline black by one part of vanadious chloride or vanadiate of ammonia. This important discovery renders it as easy to dye aniline blacks as to print them, and nothing equals the beauty of the blacks thus obtained. The power of the vanadium salts in producing aniline black is more than 1000 times greater than that of copper, and if we know the properties of vanadium this becomes easily intelligible. There is no metal which passes more easily from the minimum to the maximum state of oxidation, and returns more easily to the minimum again. If exposed to the slightest reducing influences, vanadic oxide becomes vanadious oxide, and if exposed to the fullest oxidizing agents, vanadious oxide is converted into vanadic oxide. Thus if vanadic acid is dissolved in hydrochloric acid, it is transformed into vanadious oxide, and if this latter solution is evaporated in the air, it is partly transformed into vanadic acid. On the other hand, if we bring vanadious chloride and chlorate of potash into contact, the latter is decomposed with evolution of chlorine, and the vanadious oxide is transformed into vanadic oxide, and reciprocally if we introduce vanadic oxide or an alkaline vanadiate into hydrochlorate of aniline, the vanadic oxide is at once reduced to the state of vanadious oxide or chloride. The salts of nickel, cobalt, and chrome, in presence of about 1–5000 of a salt of vanadium aid in the formation of the black.

The lowest oxides of uranium, tungsten, and molybdenum yield alone very fine blacks. But the persalts of uranium, like the tungstates and molybdates, do not react. When the salts of uranium seem to form a black, as M. Pinkney believes he has observed, it is because the salt of uranium has been obtained from a pitch blende containing vanadium. The quantity of vanadium necessary to transform aniline into black is so small that it may be practically regarded as nothing. Hence we conclude that the presence of a metallic salt, though necessary in the formation of the black, forms no part of its composition. Vanadium aniline black is identical with copper aniline black, the one containing no vanadium, and the other no copper. M. Coquillion has obtained aniline blacks by electrolysis, and the author has obtained it more easily still by introducing into a very concentrated solution of chlorate of potash and of a salt of aniline, a few drops of hydrochloric acid. No metal intervenes here, but the hydrochloric acid decomposes the chloric acid, and the products of this decomposition react upon the aniline, which they transform into black. After a few hours the whole takes a form of a paste of well-characterized aniline black. This reaction is of no use in practice because the textile fibres would be destroyed by the concentrated acid liquids. It proves, nevertheless, that aniline black is the result of the action of the products of the destruction of chloric acid upon vanadium. The reaction of vanadium pemits us to study with ease the action of the decomposition products of chloric acid upon a number of organic bodies, and upon the isomeres of aniline. Extract of logwood under the influence of chlorate of potash and a drop of vanadium salt is transformed into a yellow substance with which silk may be dyed a splendid gold-yellow. Under similar conditions the solution of hydrochlorate of toluidine (made with solid toluidine) is converted into a new substance, with which silk may be dyed a fine bronze with coppery reflection. Chloride of vanadium becomes indirectly the best reagent for aniline, and reciprocally the mixture of hydrochlorate of aniline and chlorate of potash is the best reagent for vanadium. It is merely requisite to evaporate suitably with a slight excess of hydrochloric acid the substance believed to contain aniline, and to add to it chlorate of potash and a drop of a weak solution of vanadious chloride to make the aniline black appear, whatever other substances are present.

On the other hand, we may always detect the presence of vanadium by concentrating the solutions, acidifying the hydrochloric acid, and treating with a normal mixture of salt of aniline and a chlorate. If aniline black is formed very rapidly in the cold, we may be sure of the presence of vanadium. The author gives the following conclusions:

1. Aniline black is merely emeraldine dehydrated. 2. A high temperature in the ageing rooms is necessary, not to form emeraldine, but to dehydrate it and convert it into black. 3. Emeraldine may be dehyrated even in the liquids in which it is formed by the application of heat. In a word, emeraldine is transformed into aniline black, just as the hydrated blue oxide of copper is converted by boiling into the anhydrous black oxide. 4. The essential character of hydrated aniline black (emeraldine) is to be completely destroyed by the yellow sulphuret of ammonium. 5. The essential character of anhydrous emeraldine or fixed aniline black is to be but slightly affected by the sulphuret of ammonium. This precious reagent enables us always to know whether emeraldine has or has not been transformed into black. The characters just pointed out are those of the blacks produced from *pure* aniline, which are by far the finest. 6. The blacks obtained from commercial anilines are formed of emeraldine, mauveine, violaniline and toluidine bronze. 7. By a perfect oxidation of the commercial anilines, the aniline is converted into emeraldine, and the toluidine into bronze, the mauveine and violaniline disappear almost completely, and the emeraldine, which is insoluble in acids and alcohols, may be separated from the toluidine bronze which is soluble in those menstrua. 8. We may find the amount of true aniline in the commercial aniline oils by precipitating it in the state of emeraldine and turning it into black. 9. Aniline black (typical) is dehyrated emeraldine, but in practice there are as many aniline blacks as there are mixtures of aniline and its homologues. 10. The liquid toluidines of commerce behave like mixtures of aniline and crystalline toluidine, and yield with chlorate of potash and vanadium mixtures of emeraldine and toluidine bronze.—*Bulletin de la Société Chimique.*

DOGWOOD FOR GUNPOWDER MANUFACTURE.

DOGWOOD (*Rhamnus frangula*) is supplied in bundles of long slender rods. The bundles are about six feet long, and should be thirty inches in girth at one foot from the thick end, and diminish about four inches in girth at the upper band. The wood must be perfectly free from bark, and clean. Great stress is always laid on the cleanness of the wood used for conversion into charcoal at Waltham Abbey; any traces of bark adhering to it constitute an impurity, and would condemn a supply sent in by a contractor. The specifications imposed on contractors provide that the wood shall be cut in the spring of the year. If this has been done when the sap is rising, the bark is easily removed, and the wood is left perfectly clean; but wood cut later in the year, or in winter, is perfectly as good, only in this case the removal of the bark is a much more difficult matter. To separate it the wood must be boiled, or if that is impracticable, the whole of the bark must be shaved off with a knife or spokeshave. Both boiled and shaved have been used at Waltham Abbey, but the great objection to both is that they do not keep so well when stacked as the spring-cut wood, going to decay much faster.—*British Trade Journal.*

SHALE OIL IN SCOTLAND.

THE Oakbank Oil Company, near Mid Calder, have worked the Calder shale-field for many years, and the works for the distillation of oil, etc., cover an area of 26 acres. No less than 60,000 tons of shale per annum undergo the process of distillation, while two million gallons of crude oil are refined and manufactured into burning and lubricating oils and naphtha and paraffine wax for candles; while sulphate of ammonia is also extensively manufactured from the shale. Among other matters of interest at the works, are the retorts invented by Mr. Henderson. Several of these have been erected and are working satisfactorily. They are considered a great improvement on the old vertical retorts, inasmuch as the spent shale, formerly considered useless, is applied to heating purposes, by utilizing the carbon contained in the material. Mr. Beilby's invention for the utilization of the acid tar for making ammonia, is also worthy of attention.

By a mechanical arrangement, the water issuing from the works is now separated, all that contains deleterious or chemical matter being diverted from the stream, the clean water only flowing into it. One result of this is said to be that trout are now as plentiful in the stream as before the works were commenced.

GLUCOSE FOR TANNING.

A NEW material for tanners which seems calculated to increase their profits once more to a reasonable level, and which bids fair to be extensively used for weighting leather and improving its color, is a preparation of glucose, which can be obtained at the rate of about 2½d. per pound. It is applied in a melted form to the partially dry leather, to the extent of say ten to fifteen per cent of its dry weight, although it is said to injure its quality in some degree by separating the fibres. We understand some firms already consume from two to three tons of it per month, and as we can not assume that they make less than 18d. per pound profit upon it, this quantity alone represents an income of say £4000 to £6000 a year—not a bad sum in the tanning business. On the morality of the proceeding we make no remark. The use of sugar may be detected by chewing a small slip of the leather. Glucose has been employed with success as a substitute for the objectionable materials at present used in bateing. Its price is moderate, and it will certainly remove all the lime without injury to the gelatinous tissue of the hide; but whether it will give the requisite softness and flexibility is a question we can not at present answer from personal experience.—*Curriers' Journal.*

[American Chemist.]

CHEMICAL NOTES.

By J. M. MERRICK, B.SC.

Molasses-Sugar.—Sugar-refiners are often, to borrow a vulgar phrase, "stuck" with lots of second-boiling sugars, imposed upon them or the importers by foreign dealers, as first-boiling or "straight" sugars. These look well, and often polarize higher than an equally good-looking "straight" or first-boiling sugar; but when they come to be worked, they break down, and give an excess of molasses or syrup, and by no means the theoretical yield of sugar. To exhibit a ready means of detecting a second-boiling sugar chemically, or by polarization, would be a very valuable matter for chemist and refiner. As the defect in the second-boiling sugar lies in its greater readiness to go over into uncrystallizable sugar, it has occurred to me that a series of experiments in determining the comparative *time* required for the complete conversion into left-handed sugar of a good "straight" sugar, over a second-boiling sugar of the same class, might throw light on this problem, and pave the way to a method of analysis. It is needless to say that the experiments would have to be conducted with great nicety, and especially at absolutely identical temperatures.

Cream of Tartar.—The steadily increasing demand for this chemical, the supply remaining probably about the same, leads the manufacturers to leave in their product as much tartrate of lime as possible. I have recently analyzed samples with 12 to 14 per cent, while 6 per cent used to be a full amount. It seems obvious to me that this adulteration must especially injure the cream of tartar for making pharmaceutical preparations, by the substitution of 12 per cent of a substance which at best is inert or useless.

Lecture Experiment.—A rather pretty lecture experiment may be arranged to show the low temperature of a flame, by boiling in a long-necked flask a bit of phosphorus with five times its weight of lime. The flask should have a long tube fitted to it by a tight cork. As the phosphoretted hydrogen (probably carrying other phosphorous compounds) issues from the tube, it burns with a pale-green flame, and in this flame a common match may be held for a long time without taking fire. I have reason to think this experiment dangerous.

ON THE SPECIFIC HEAT OF MERCURY-VAPOR.

A. KUNDT and E. WARBURG.

THE quantity of heat contained in a gas is usually defined as the total energy of its molecules, and, if the molecule is looked upon as a material point, this energy consists alone in onward motion. Knowing the pressure exerted upon the unit of surface by a quantity of gas contained in the unit of volume, and knowing the increase in the pressure produced by increasing the temperature 1°, we can easily determine the quantity of heat used in thus raising the temperature 1°, the volume remaining constant. If all the heat which affects the vapor is transformed into energy of onward motion of the molecules, we can easily calculate how much heat *ought to be* required to raise the temperature of the unit of volume of a gas through 1°, the volume remaining constant. This latter calculated value is smaller than that found by experiment, and hence it is concluded that in reality some of the heat which is used in heating up a gas under ordinary conditions does some kind of internal work, and this is possible, inasmuch as the molecules of most gases are not material points, but consist of atoms. On studying mercury-vapor, it was found that the calculated and observed values above referred to were equal, and this result is in accordance with the commonly accepted view that the molecule of mercury is monatomic. According to the experiments here described, the molecule of mercury-vapor acts as if it were a material point.

ON THE DETECTION AND DETERMINATION OF NITROUS ACID IN NATURAL WATERS AND OTHER VERY DILUTE SOLUTIONS OF THE SAME.

P. C. PLUGGE.

AFTER a critical examination of Fresenius' method of obtaining a more concentrated solution of nitrous acid by distillation with acetic acid, the following conclusions are stated:

1. Fresenius' method is not adapted for quantitative determinations as proposed by Fischer.

2. The commercial so-called pure acetic acid always contains substances which are carried over with the distillate, and which are oxidized by the potassic permanganate solution. It should, therefore, not be used when it is intended to determine the nitrous acid by Kubel's method.

3. The reduction of nitrates as maintained by Kämmerer does not take place. There is, therefore, no reason for substituting acetic for sulphuric acid in the distillation of nitrous acid.

4. The portion of the nitrous acid which is not distilled over, is either entirely or in great part converted into nitric acid.

CONCERNING THE FLAME THEORY.

KARL HEUMANN.

THE fact that between a burner and its flame there always exists a space where there is no flame, has been explained by supposing that in this space the gas mixed with air before the burning commenced. It is here shown that such spaces exist wherever a cold body comes in contact with the flame; the space is the larger the colder the body is, and the greater its power of conducting heat. If a hot metallic body is introduced into a flame, the latter remains in contact with it. It follows that the cooling of the flame by the burner or by the body introduced into the flame, is the sole cause of the observed space.

[Engineer.]

INSTRUMENT FOR MARKING ASTRONOMICAL TIME.

By E. K. HORN.

FIG. 1 represents simply a sliding vernier attached to a graduated scale, the vernier to be moved gently and regularly forwards and backwards by hand, in unison with the beat of a time-keeper vibrating seconds of time; then if the vernier be stopped at the signal of the observer it will mark the elapsed interval since the preceding second. With this simple instrument great accuracy is not aimed at, but as after a little practice the time recorded by it may be assumed at within a tenth of a second, it may be found useful as a companion to the chronometer either in the camp or on ship board. If greater accuracy be required, let Fig. 2 represent a metronome beating seconds of time with a graduated arc placed at the back of the upper part of the pendulum, which latter carries with it at the extreme end a vernier vibrating freely, just barely clear

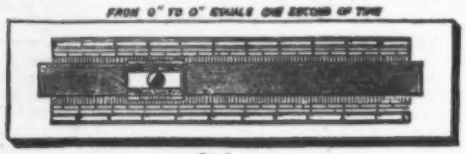


FIG. 1.

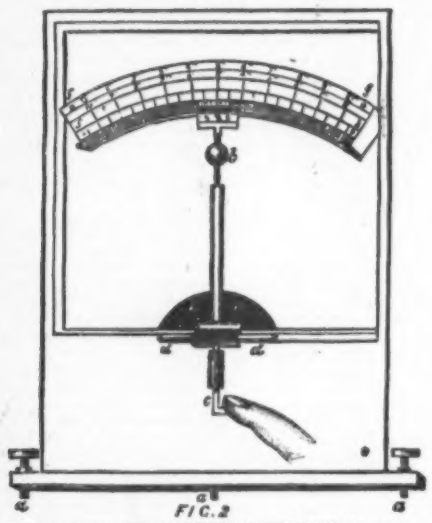


FIG. 2

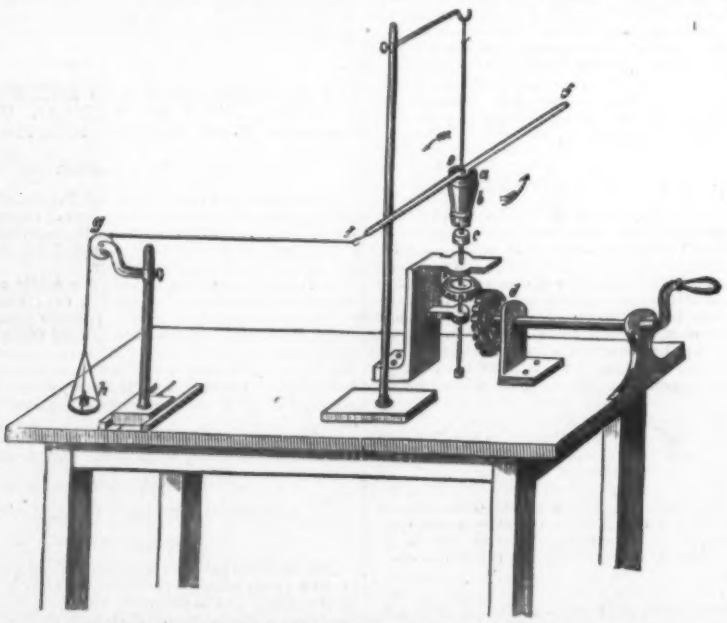
INSTRUMENT FOR MARKING ASTRONOMICAL TIME.

of the graduated arc. Let *a a a* be three foot screws for adjusting the perpendicularity of the pendulum; *b*, a ball for adjusting the vibrations of the pendulum to seconds of time; *c c*, a sliding trigger; *d d d*, a spring clamp—similar to a letter clip—on cardboard, but clipping, when free, against the pendulum, and locking it against the leather plate *e e*; *f f f f*, adjusting screws for bringing the graduated arc into coincidence with the vernier. When the instrument is required for use, raise the spring clamp and set it under the trigger; adjust the pendulum perpendicularly by the foot screws, and its time rate of seconds by the ball *b*, then set the pendulum going in unison with the vibrations of the time-piece. At the instant of the observer's signal—or the observer may be furnished with a signal wire attached to the trigger—free the clamp which locks the pendulum, note the preceding second, and the vernier will record the elapsed interval since with considerable accuracy.

[Nature.]

THE MECHANICAL EQUIVALENT OF HEAT.

M. PULUJ, of Fiume, has recently published a description of a school apparatus for determining the mechanical equivalent of heat. The apparatus is of very simple construction,



APPARATUS FOR ILLUSTRATING THE MECHANICAL EQUIVALENT OF HEAT.

and consists of a calorimetrical and a dynamometrical part, which is connected with a rotating arrangement, such as may be found in any physical laboratory.

The calorimetrical part of the apparatus is formed of two truncated hollow cones of cast-iron, fitting the one into the other. The inner one, *a*, does not quite reach to the bottom of the outer, *b*, and it projects a little above it. The outer cone, *b*, can be fixed, co-axially, into the spool of the driving machine. The inner cone contains mercury. If, now, the driving machine be set a-going and the inner cone held fast, heat is produced through friction of the touching surfaces of the cones.

For measurement of the work transformed into heat, the arrangement is as follows: To the wooden lid, *e*, of the inner cone is screwed a light wooden beam, *f*, horizontally. Through the beam and lid passes a perforation for receiving the thermometer. At a little distance from the beam, *f*, and at the same height, there is a fixed pulley, *g*, over which is passed a cord with a scale at its pendant extremity, while the other end is attached to the end of one arm of the beam (the second arm of the beam acts as counter weight). When the driving machine is put in action, the cones rub together, and the outer cone tends to carry the inner one and its beam round with it in the direction of rotation. With a certain weight in the scale, the horizontal part of the cord will form with the axis of the beam a right angle. From the length of the beam-arm, the amount of weighting, and the number of rotations, may be deduced the work that is transformed into heat; and from the water value of the calorimeter, and the increase of its temperature, can be reckoned the quantity of heat produced.

From twenty-eight experiments (in which the amount of heat radiated from the calorimeter was taken into account), the average value obtained for the mechanical equivalent of heat was 425·2, with a mean error $\pm$ 5·4. A second series of experiments was made, with the arm of the beam in any position with reference to the cord. A simple arrangement—wooden triangle with arc-division—served for measuring the angle which the axis of the beam-arm formed with its normal position (in which it forms a right angle with the cord). From the observed values of this angle, and from the quantities already referred to, the number obtained for the mechanical equivalent of heat was 426·7, with a mean error $\pm$ 5·9.

The apparatus is especially to be recommended for lecture experiments, because the method of experimenting is extremely simple, and the carrying out of the experiment takes very little time. A single experiment occupies 30–60".

[Chemical News.]

POCKET BLOWPIPE.

By P. CASAMAJOR.

Pocket Blowpipe.—In his incomparable book, "On the Use of the Blowpipe in Chemical Analyses and Mineralogical Determinations," Berzelius says that "As it is very desirable, especially for those who study mineralogy, that the blowpipe should take up little room and be convenient to carry without depriving it of its essential qualities, several chemists have endeavored to attain the last limit of simplicity in the construction of this instrument. The most remarkable blowpipes in this respect are those of Tennant and of Wollaston."

Not being fully satisfied with these, nor with other forms which have come under my notice, I have endeavored to attain "the last limit of simplicity," in the instrument represented in Figs. 1 and 2. The former represents the blowpipe packed for carrying in the pocket with the jet put away inside of the main tube, while Fig. 2 represents the same instrument with the jet in its place when ready for use. The main tube is a cylinder with an elliptical section, which is preferable to a circular section, as the curved jet takes up considerable room in one direction, which would entail the necessity of having a circular tube of about half diameter. This would be clumsy to carry and inconvenient to blow into. A tube, whose section is an ellipse with a major axis of half an inch, may be made quite flat, affording a small package for the pocket and a convenient mouthpiece.

In Fig. 2, representing the blowpipe as mounted for work, I have sketched with dotted lines another blowpipe with a jet of the usual shape, that the portability of the new blowpipe may be appreciated, while it may be seen that in every essential quality it does not differ from the one with the full length of stem.

For the length of blowpipes, Berzelius gives the distance of 8 inches from the mouthpiece to the tip of the jet, adding, however, that for every operator this distance must be such as to afford the clearest view of the substance under examination. A blowpipe similar to the one represented in Figs. 1 and 2, which I have in my possession, and whose length from the mouthpiece to the tip of the jet is 8 inches, has a main tube whose length is only 4¼ inches. The relation of 4¼ to 8 is a trifle less than that of Dr. Wollaston's blowpipe as given by Berzelius in the two conditions of being packed for the pocket and ready for use. This advantage is obtained by using a curved jet, which also enables the flame to take a more convenient direction than with straight but oblique jet of Dr. Wollaston's blowpipe.

If the stem of the blowpipe is made in two pieces, while the jet is made with a double curve, the length when put up for the pocket can be reduced to 3½ inches, which gives the still smaller relation of 3½ to 8, which I believe has never before been attained. I have one of these dimensions whose stem is formed of two conical portions with circular sections. When packed for carrying, one cone fits within the other, and the curved jet is placed inside of the inner cone. As the stem when developed is longer than when made of only one piece, the jet is shorter and less curved than that represented in Figs. 1 and 2, and it finds ample room in the

Fig. 1. Scale ½

Fig. 2. Scale ½

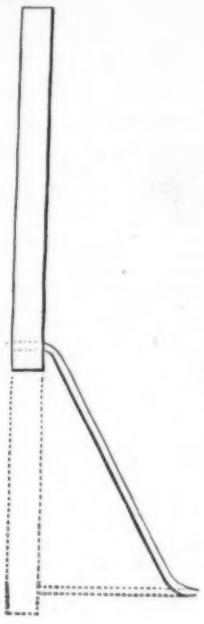


Fig. 3. Scale ½

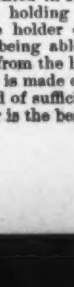
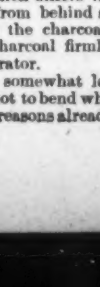


Fig. 4. actual size



POCKET BLOWPIPE.

inner cone. By making the two portions of the stem cylindrical, and screwing them together, a more clumsy and expensive instrument is obtained, but also one whose portions are held more firmly together.

To avoid projections on the surface of the blowpipe, the socket in which the jet is inserted is formed by a tube soldered at both ends in the interior of the blowpipe. It is indicated by dotted lines in Figs. 1 and 2. On the side of this tube a hole is pierced to allow the air to pass out into the jet.

When the jet is put up in the interior of the stem, it may be wrapped up in a piece of paper to keep it from dropping out. When needed, it may be picked out or shaken out.

Mouthpieces.—Extra mouthpieces of horn, wood, or ivory should be avoided, as they invariably fit loosely. Berzelius advises that blowpipes be made either of silver or tin-plate without extra mouthpiece; those made of brass are disagreeable to the mouth and leave a bad smell on the hands. Although silver is a better conductor of heat than any other substance, Berzelius tells us that he was never inconvenienced by the heating of his silver blowpipe even after very prolonged blowing.

Plating brass with either silver or nickel can only be considered as a palliative, as the nobler metal soon wears off. German silver is a very good material for blowpipes, as it is almost free from taste and smell when clean, and is a bad conductor of heat.

For blowpipes made of baser metals, mouthpieces may be made of silver and soldered on. I can propose another material which fits tightly on the stem, which is pleasant to the mouth, and which may be renewed in a few seconds at a trifling expense. This consists of a piece of rubber tubing slipped over the mouth of the blowpipe.

Charcoal-Holder.—Charcoal, although one of the most necessary agents in blowpipe analysis, is also one of the most troublesome on account of its bulk, which is disproportionate to that of every other substance employed in determinations of this kind. This defect is aggravated by the circumstance that only a small portion serves as support, while the greater part is used as a handle to keep the useful portion at a safe distance from the hand of the operator. A consideration of this and a desire of economizing a troublesome agent induced me to cut up my charcoal into blocks of various sizes, about as long as they were wide, which I tried to hold before the blowpipe flame by means of tongs and forceps. Finding the use of these inconvenient, I was led to adopt the charcoal-holder represented in Figs. 3 and 4, which differs from tongs and forceps in holding the charcoal from behind so that no portion of the holder comes between the charcoal and the flame, and in being able to hold the charcoal firmly without any pressure from the hand of the operator.

This holder is made of metallic strip somewhat less than ¼ inch wide, and of sufficient thickness not to bend when in use. German silver is the best material, for reasons already pointed

out. Two strips are cut about 4 inches long, and bent in such a way that each piece has one of the jaws for holding the charcoal, and a projection for varying the distance between the jaws. After giving to each piece its proper shape, they are placed in position and strapped together with two pieces of the same metal. These should not be put on too tightly, as a certain freedom should be allowed to regulate the opening between the jaws.

Clay Pipes for Support.—Fragments of a clay-pipe bowl, and even pieces of pipe-stems held before the blowpipe flame, form excellent supports for exhibiting the colors which metallic oxides afford with borax and salt of phosphorus. These fluxes, on being heated, coat the surface of the white clay with a glaze, on which may be seen the colors due to the oxidizing and the reducing flames. The flux should first be melted so as to coat the white clay with a transparent colorless glaze. If now we add a substance containing copper and expose the glaze to the oxidizing flame, a bright green enamel will be obtained. If now a portion of the edge of the enamel, or some other small part of the glazed surface, is touched with the reducing flame, the dark red color of cuprous oxide will be exhibited by the side of the color due to the oxidizing flame. In the same manner, with manganese, the oxidizing flame will give a violet enamel, which may be decolorized in spots by the reduction flame.

The fragments of baked clay may even, to a certain degree, replace charcoal as supports to effect reductions to regulus and to exhibit some of the rings presented by volatile metals. These reactions are best shown by mixing the substance under examination with cream of tartar or one of its substitutes, such as a mixture of carbonate of soda and flour.

After being carbonized by the application of a reduction flame, the mass may be triturated with water in an agate mortar. The metallic grains obtained with cream of tartar are even larger and more distinct than those obtained with carbonate of soda on charcoal. The rings exhibited by volatile metals are best seen if they are colored, as those exhibited by lead and bismuth. White rings are not plainly seen on white clay, but may be exhibited on pieces of red or black terra cotta.

When using pieces of white clay before the blowpipe, it is interesting to notice that an oxidizing flame leaves the clay white, while a reduction of flame gives immediately a grey tinge which deepens as more carbon is deposited.

I have called attention to these supports, as the material is always at hand and forms a great resource to a chemist who may not have either charcoal or platinum wire at hand. The pieces of clay pipe may be held in the charcoal-holder already described, or with tongs or forceps, or, at the last resort, by pieces of wire conveniently twisted.

Other Supports.—When chalk is heated before the blowpipe, nearly the whole of its carbonic acid is driven off, but the lime that remains keeps the shape of the chalk, and may, on account of its infusibility, be used as support to effect reductions of metallic substances and to hold cupels of bone-ash. These are made by boring cavities in the chalk, which are afterwards filled with bone-ash slightly moistened. The surface of the cupel is formed by pressing on it with the agate pestle. Berzelius recommends that cupels be made in this manner in cavities made in charcoal. I have substituted chalk for charcoal, as the latter burns away too rapidly from under the cupel. If no bone-ash is at hand, as light depression may be made on the surface of the chalk itself, and on this scorifications and cupellations may be carried on, as lime is very porous as well as infusible. As the surface of the lime cracks into little fissures, it is better to heat it first and press it down with the agate pestle. Even after this has been done, care should be taken to prevent loss of material by keeping a constant watch on the globule of workable lead as it dwindles down.

Another material to form supports for cupels is found in fragments of black-lead crucibles, in which cavities are easily bored. The charcoal-holder before described may serve for these supports of graphite or of chalk.

["Electricity and the Electric Telegraph." A new work by George B. Prescott.]

THOMSON'S APPARATUS FOR WORKING SUBMARINE CABLES.

FOR long cables the astatic form of Thomson's reflecting galvanometer, shown in Fig. 1, is frequently employed as a receiving instrument. Fig. 2 is a sectional view of the coils, about half the actual size, showing the mirror M and the lower needle N, but which requires no detailed description in this place. When these instruments are used for receiving communications through the cable, they are placed in a box or curtained compartment, and the receiver calls off each

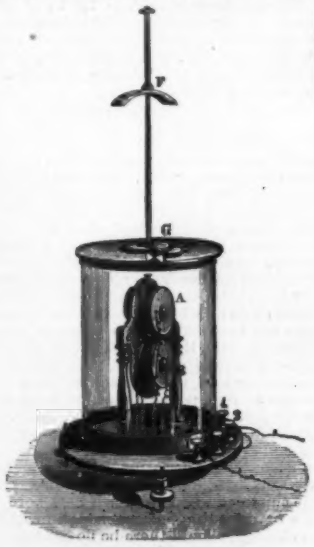


FIG. 1.

word to a clerk in attendance, who writes it down. The spot of light wanders over the scale, following every change of current, but the operators, by practice, acquire the necessary skill to interpret the apparently irregular motions. One dot will cause the light to almost cross the scale, the second moves it a little farther, the third or fourth causes hardly a perceptible motion, but the receiver knows by experience that these four very different effects each indicate a single dot, all of them being sent by the transmitting operator in precisely the same manner.

THOMSON'S SYPHON RECORDER.

This beautiful apparatus was also invented by Sir William Thomson, who has contributed, perhaps, more than any other person to render submarine telegraphy commercially practicable. The syphon recorder is so arranged as to actually delineate on paper the apparently irregular movements of the galvanometer needle above referred to. A fine glass syphon tube conducts the ink from a reservoir to a strip of paper which is drawn past the point of the tube with a uniform motion. The point moves to the right or left of the zero line through distances proportional at each instant to the strength of the current, and thus the signals are drawn on the paper in the form of curves representing the strength of the current at each instant of time. Figure 3 shows the form of syphon recorder in use at the Duxbury station of the French Atlantic cable. The apparatus consists of a very light rectangular coil *b b* of exceedingly fine insulated wire, suspended between the poles of a large and powerful electro-magnet N S, which is charged by a local battery of large size. Within the coil is a stationary soft iron core *a*, which is powerfully magnetized by induction from the poles N S. The coil *b b* swings upon a vertical axis, consisting of a fine wire *f f*$_1$, the tension of which is adjustable at A. The received current passes through the suspended coil, the suspension wire *f f*$_1$ serving as the conductor; the coil is impelled across the magnetic field in one direction or the other, according to the polarity and strength of the current passing through it. The magnetic field in this arrangement is very intense and very uniform, which makes the apparatus sensitive to the weakest currents. The syphon *n* consists of a fine glass tube turning upon a vertical axis *l*; the shorter end is immersed in the ink reservoir *m*, and the longer end rests upon the paper strip *o o*. The syphon *n* is pulled backward and forward in one direction by the thread *k*, which is attached to the swinging coil *b b*, and in the other by means of a retracting spring attached to an arm on the axis *l* and controlled by the adjusting spindle *g*. The paper is caused to move at a uniform rate by means of gearing driven by a small electro-motor. Fig. 4 is a fac-simile of the writing of the syphon recorder at a speed of eighteen or twenty words per minute through a cable of about 800 miles in length. The upward waves represent dots and the downward waves dashes, and by bearing this in mind the words "syphon recorder," written in the International alphabet, may be readily traced out. In working very long cables, the action of the current upon the swinging coil is very feeble, and the friction of the syphon against the paper strip, if allowed to come in actual contact with it, would interfere with the freedom of its movements. In such cases the point of the syphon does not actually touch the paper; the ink and the paper are oppositely electrified by means of an inductive machine driven by the same electro-motor which moves the paper. The electrical attraction causes the ink to be ejected from the syphon upon the paper in a succession of fine dots. Fig. 5 is an example of the record made in working through a long cable. The apparatus at Duxbury, shown in Fig. 3, has been materially modified from the original plan, and its working much simplified and improved, by Mr. Cuttriss, the mechanician at that station.

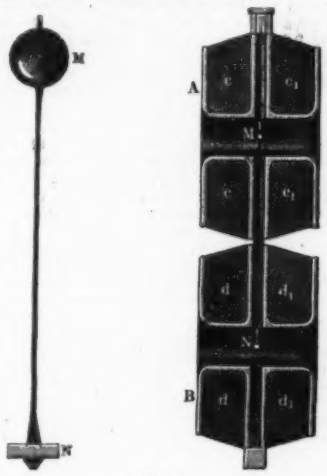


FIG. 2.

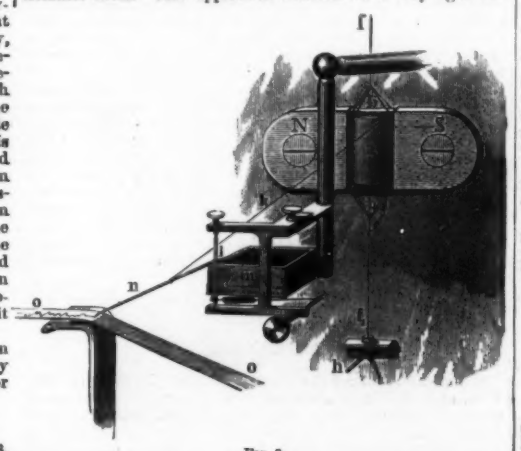


FIG. 3.

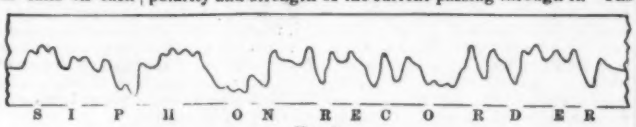


FIG. 4.

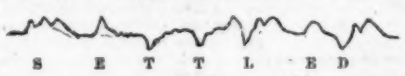


FIG. 5.

[Engineer.]

THEORIES OF THE RADIOMETER.

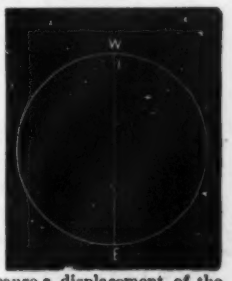
FROM observations made when using the vacuum balance, Mr. W. Crookes, F.R.S., was led to further experiments on the attraction or repulsion of light and heat. The results of these experiments were of a rather startling character, and were considered by the author to be of sufficient importance to be brought before the notice of the Royal Society. This was done in a paper presented to the society on August 12th, 1873, and read, we believe, on December 11th following. Prof. Osborne Reynolds, in a paper sent to the Royal Society May 16th, 1874, and read June 18th, endeavored to prove the phenomena recorded by Mr. Crookes to be owing to forces caused by "evaporation from, and condensation at, a surface." Further experiments, however, in which it is difficult to see how any gas or vapor could affect the result, have been made by Mr. Crookes, and the results given in a paper presented to the Royal Society, and read on April 23d, 1875. In the July number of the *Quarterly Journal of Science* of last year, Mr. Crookes contributed an article describing popularly his experiments and the obtained results. Several efforts have been made to explain the phenomena obtained—phenomena which can be seen by any one, for the radiometers are now made and sold to the public—but the explanation has generally broken down under scrutiny. Quite recently, however, a theory has been put forward by Rev. A. J. Stevens, M.A., Fellow of St. John's College, Cambridge, which deserves close attention, for by it we may not only explain the phenomena obtained by Mr. Crookes, but other phenomena well known to scientific men and met with in various branches of physics. Referring to the phenomena of attraction and repulsion, Mr. Stevens says:

I propose to explain these effects as being due to certain dynamical conditions produced by the incident radiation in the superficial layers of molecules of the body experimented upon. The explanation which I propose depends on a certain hypothesis as to the constitution of the ultimate atoms of matter. The essential parts of my hypothesis are:

(1) That the mass of the atom—namely, any atom—is not uniformly distributed throughout the space enclosed by the bounding surface of the atom; but that it is concentrated towards one point, which may be called the *nucleus*, situated comparatively* near to the bounding surface. The portion of the atom nearest to the nucleus I shall call the inert end of the atom; and the portion which is farthest off I shall call the sensitive end. I shall assume that the point of the bounding surface which is nearest to the nucleus and that which is furthest off are in a straight line with the nucleus; and that this line, which I shall call the axis of the atom, passes through the centre of inertia of the atom. Further, if the bounding surface of the atom be a surface of revolution, the mass of the atom will be supposed to be symmetrically distributed with reference to the geometrical axis of the bounding surface.

(2) That the actions between the atom and the luminiferous ether, so far as light and heat are in question, take place only at the sensitive end of the atom, and in a direction at right angles to its axis.

Let A be the plane face of a solid lamina, of suitable dimensions for one of Mr. Crookes' experiments; and let radiant light or heat be perpendicularly incident on A. And let B be the face opposite, equal and parallel on A. Suppose, for simplicity, that the faces of the lamina are accurately plane, that the lamina is composed of a crystalline substance, which is not transparent to any of the radiation, and that the atoms of one of the elementary substances, Q, which enter into its composition are bounded by spherical surfaces. Consider the superficial layer of the molecules of the face A. In every molecule there are a certain number of Q atoms, each of which is definitely situated. Suppose, in the first place, that in each of these molecules one of the Q atoms is placed with its axis at right angles to the plane A, and its sensitive end turned outwards, that is, towards the source of radiation.



Let the figure represent any section of the atom by a plane passing through O its centre of figure, and I its centre of inertia. Then E O I W is the axis of the atom; the portion of the atom near W is the inert end, the portion near E is the sensitive end, and E W is the direction of the incident rays. The ethereal light or heat vibrations which arrive at the point E are at right angles to E W, and at any given instant have a definite direction. I conceive that the tendency of the ethereal disturbance at E is to cause a displacement of the sensitive end of the atom, and that if the atom were not constrained by its connections with the neighboring atoms,† and if the ethereal vibrations which arrive at E were all polarized in a given plane, the atom would be caused to oscillate or to rotate about a line passing through its centre of inertia I in a direction at right angles to the direction of the ethereal vibration. In the actual case we are considering the atom is not free, but constrained in consequence of its connections with the neighboring atoms, and the direction of the incident ether vibrations is not constant. Supposing, however, that it were constant, then I conceive that the atom would be made to oscillate, and that a component part of its oscillation would be about some line parallel to the plane face A, and intersecting the axis E W of the atom in some point betwixt E and I.‡

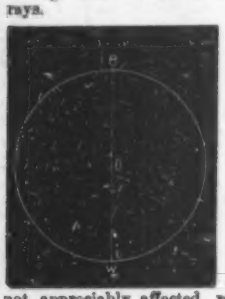
In the actual case the direction of the ethereal vibrations at E is not constant, but it changes continuously; or, at least, it changes continuously during successive intervals of time which in general are great in comparison with the periodic

* Perhaps, in some cases, very near.

† For the present I am leaving out of account the atomic motion due to the "free heat"—which has been called "thermometric heat" by Rankine, and "freie Wärmemenge" by Clausius—existing in the body before the incidence of the radiation.

‡ Bearing in mind section I. of the hypothesis enunciated above.

interval of the ethereal vibration. In this case the axis of oscillation of the atom will be continually changing;* but there will always be a component part of the oscillation about some line at right angles to the axis of the atom, and intersecting it in some point between I and E, remembering that I may be supposed very near to the bounding spherical surface of the atom, according to my hypothesis above enunciated. In consequence of this a centrifugal force is produced, the average effect of which is in the direction of the incident rays.



Next consider an atom with its axis parallel to the incident rays, and its inert end E turned outwards, namely, towards the source of radiation. The ethereal vibrations which arrive at W will, according to my hypothesis, produce no effect on the atom, hence they will be reflected.

Next consider other Q atoms, whose axes are inclined at any angles to the incident rays. Those whose inert ends are tilted towards the source of radiation will not be affected, or not appreciably affected, remembering that their bounding surfaces have been chosen spherical, and that their sensitive ends may be supposed to extend over only a small portion of their bounding surface at the extremity of the axes. Those whose sensitive ends are tilted towards the source of radiation will be affected in varying degrees; and in each such atom a centrifugal force will be produced acting towards their inert ends. A component part of each such force will be at right angles to the plane face; and supposing, for simplicity, that their axes are equally distributed in azimuth about the direction of incidence, it follows that: The incident ethereal vibrations produce in the Q atoms of the superficial layer of molecules a resultant force acting as a repulsion from the source of radiation.

Similar considerations would show that in the elementary atoms of other kinds, which are in the superficial layer of molecules, a force of repulsion would be produced. As regards the layers of molecules which are very near to the superficial layer, it is, I think, conceivable that a similar effect would be produced in them, but to a less degree. I have not taken into account the fact that before the radiation was supposed to be incident on the lamina, its atoms were already in a state of vibration corresponding to the free heat of the body. The magnitude of the repulsive force produced would possibly be affected by this circumstance. At least this would be the case if the initial temperature of the body were such that its viscosity increased rapidly for small increments of temperature. The above reasoning would evidently be applicable to a non-crystalline solid; and on the whole I conclude that when a solid, whose temperature is considerably less than that at which great structural alteration begins to take place, receives radiation from a source of light or heat, a repulsive force is produced in the superficial portion of the body, and it is greater or less according as the body's capacity of absorbing the radiation is greater or less. Next, suppose a cold body, as a lump of ice, to be used instead of a source of radiation, the temperature of the lamina being supposed to be considerably higher than that of ice. Before this is supposed to be done, however, and while the lamina is still supposed to be in thermal equilibrium with surrounding bodies, let us consider two atoms, one in each face of the lamina, each atom having its axis (this for simplicity of ideas) perpendicular to the plane face, and its sensitive end turned outwards.

Let E be the sensitive end of one of the two atoms in question. Then I say that E is incapable of taking up any of the ethereal vibrations which are coming to it; for if E were capable of taking up any portion of such vibrations, the atom W E would necessarily pass on a part of what it took to the interior of the body, owing to, and by means of, its connections with the neighboring atoms, and the temperature of the body would thereby be raised above that of the surrounding bodies, which is contrary to the Second Law in thermodynamics. Hence all the energy that is radiated to the body is reflected (using this word in a somewhat extended sense, to mean that the energy which comes from the surrounding bodies to the superficial layer), goes away again, though in what direction it goes does not appear from the reasoning, which is simply concerning quantities of energy. From Prevost's theory of exchanges it would appear as if a part of the energy which arrives at the sensitive ends is reversed in direction. It must also be remembered that it is assumed that absolutely no internal work (Clausius' "innere Arbeit") is done within the body or on the superficial layer by the free heat, a condition which I suppose is not perfectly realizable in nature. (What I say is that under the circumstances considered no energy can get into the body, neither can any energy come out of it.) Let the ice be now supposed to be placed in front of A. Then the energy of the vibrations of the atoms, whose sensitive ends are turned towards the ice, is almost instantaneously considered diminished. This is owing to the enormous difference in the velocities with which the energy (of vibrations) is transmitted in the body (by conduction) and in the ether (by radiation) respectively. For the energy of the ethereal vibration close to E, the sensitive point of W E is almost instantaneously considerably reduced, owing to the introduction of the ice; and the ether close to E is able to take from the atom W E all the free energy which it possesses in excess of its own, and this is done immediately; and, although the free energy of the interior parts of the body has not been appreciably diminished, it can only be communicated comparatively slowly by means of the connections between neighboring atoms.

And thus the centrifugal force of those atoms which are in the superficial layer (or layers) of molecules of the face A, and whose sensitive ends are turned outwards, is suddenly diminished by a considerable amount, while no change has taken place in the superficial layers of the other face B. Hence a resultant force is produced towards the ice.

On p. 346 (in his article in *Quarterly*) Mr. Crookes states that "at the highest exhaustions dark heat from boiling water acts almost equally on white pith and on pith coated with lampblack, repelling either with about the same force." I infer that the white pith and the pith coated with lampblack possess nearly equal capacities of absorbing the radiations proceeding from boiling water under the conditions of Mr. Crookes' experiment.

If a solid body be composed of an elementary substance, whose atoms are not combined into molecules, or of a mixture of two or more elementary substances, whose atoms are not combined into molecules, the surface of such a body would in general present as many inert ends of atoms as sensitive ends to incident radiation. (In such a case it would seem that, according to my hypothesis, as least as much of the radiation would be reflected as is absorbed, the body being supposed not transparent to any of the radiation.) If such a surface were gently rubbed, it appears to me that the atoms whose sensitive ends were exposed would be most liable to be affected by the process. Such atoms might be knocked away by the rubbing, or displaced more or less (welded round, in fact), and the surface would gradually acquire an increased capacity for reflecting radiation. Thus the reflecting power of polished metallic surfaces may, in some measure, be accounted for. The case of lampblack, which has no appreciable capacity for reflection, and yet is an elementary substance, I would explain by the supposition that the carbon atoms are combined into molecules; and that these molecules are comparable to nodules: a number of atoms clinging together with their inert ends brought as close as possible to each other. It may be indeed that the atoms of solids are almost always combined into molecules; and this would not be surprising on my hypothesis. For, if the nuclei (see enunciation of hyp.) of some kinds of atoms are very near to their bounding surfaces, such atoms might be very liable to stick to each other in groups through the effect of their gravitation.

Transparency of solids is a property which I am unable to explain on my hypothesis, though I think that the possibility of an explanation is not inconceivable. But has it yet been satisfactorily explained on any hypothesis? It must be remembered, moreover, that the connections of neighboring atoms are of exceeding importance in all such questions, and these connections are no less mysterious than the atoms themselves.

If the idea (which is one of the essential parts of my hypothesis) of the eccentricity of the centre of inertia be applied to molecules, some assistance might thereby be furnished towards explaining the evaporation of liquids. Suppose that the molecules of a liquid were composed of groups of atoms in such a manner that the nuclei of the atoms of any molecule were as close together as possible, then the centres of inertia of such molecules might in many cases be very eccentrically situated. Now if the molecules of a liquid are in very rapid rotation (which is not inconsistent with my hypothesis, but rather suggested by it), then a large number of the molecules in the free surface of such a liquid (whose molecules have their centres of inertia very eccentrically placed) would have a tendency to jump, and so would escape from the liquid; and thus evaporation would be explicable without ascribing (as is done in the dynamical theory of gases) any free path to the molecules, while as yet they are in the interior of the liquid. But they would be considered to take their liberty at the free surface. And thus some light would be thrown on the way in which molecular heat-motion may be transformed into the motion of visible masses, and *vice versa*. In conclusion, I think it is suggested by my hypothesis that the ultimate atoms of matter are constituted on one single elementary basis.

[Academy.]

ASTRONOMY.

Solar Eclipses.—The reports of the Eclipses of 1871, 1874, and 1875 have been published nearly simultaneously, the two former in the *Memoirs of the Royal Astronomical Society*, and the latter by the Indian Government. Though the results have long been made known by means of telegrams, the detailed reports will be welcomed if only for the valuable plates with which they are illustrated. The observations of the eclipse of 1871 were important from their establishing the solar origin of the corona, and to this valuable result the party under Colonal Tennant (of which the report is now published) largely contributed. Colonel Tennant succeeded in obtaining six photographs during the two minutes of totality, and of these, four are reproduced in exquisite steel engravings, which show in the corona a structure of a most wonderful character, consisting of radiating wisps, which, in some places, cross each other, leaving great rifts extending down to the sun's limb, and of which the most marked are near the poles. The whole appearance somewhat resembles that of sunbeams with the dark shadows between, though infinitely more delicate and complicated. Much of the detail of structure which is brought out by a careful examination of the photographs is too delicate to be represented by the finest steel engraving, but enough is shown in the plates to suggest quite new ideas as to the nature of this wonderful appendage of the sun. We shall doubtless be able to form a better notion of its constitution when the results of various eclipses are brought together in the long-delayed Report on Eclipses which was to have preceded the present volume of the *Mémoirs*. The spectroscopic results obtained by Colonel Tennant were as valuable as his photographs, for besides establishing conclusively the existence of that layer in the sun's atmosphere which, according to Kirchoff, gives rise by its absorption to the dark Fraunhofer lines, and whose presence had been first detected by Professor Young in 1870, when it was found to emit the corresponding bright lines as soon as the enormously brighter background of the sun's photosphere was cut off by the moon, Captain Herschel traced the bright line in the green (1474 K.) in every part of the corona, even in the dark rifts where no trace of the continuous spectrum of reflected sunlight was to be found. These rifts would then be true shadows, in which the sun's light is cut off, though the coronal substance remains. The eclipse of 1874 (visible in Southern Africa) attracted comparatively little attention in this country, but Mr. Stone, though thrown entirely on his own resources, succeeded in organizing observing parties at widely distant stations, from which most instructive drawings of the corona were obtained, the result being to show that the aspect of the corona is the same at places more than five hundred miles apart, and that the discordances between drawings made by different persons at the same place are due to the attention of the observer being directed more especially either to the inner or outer corona, to the neglect of the other. Both parts of the corona are thus shown to be solar; and this view is further supported by Mr. Stone's observation of the bright line in the spectrum of the corona at a distance of more than a degree from the sun's centre. Besides this, some absorption (Fraunhofer) lines were seen in a continuous spectrum, and in the inner corona the bright lines of hydrogen. One striking feature of the corona in this eclipse was its contraction in the direction of the sun's axis, and something similar to this was seen in 1869 and 1871. The Report of Captain Waterhouse on the eclipse of 1874, which was to have been observed at Camorta, in the Nicobar Islands, is interesting as an account of preparations for a new mode of observation, though unfortunately a cloudy sky prevented any results being obtained. Though the expedition, as sent out from England, was very incompletely equipped, Captain Waterhouse with the Indian party succeeded in getting the various instruments into working order in time for the eclipse. Besides a camera attached to an equatorial for obtaining direct photographs of the corona, there were two arrangements with which it was intended that photographs of the coronal spectrum should be taken. One of these was composed of a single prism spectroscope with heliostat, having as a camera the Janssen slide used at the transit of Venus, which permitted a number of photographs to be taken in succession on different parts of the same plate, and thus avoided the waste of time consequent on changing plates. The other apparatus was simply a spectroscope attached to the Browning reflector, with a camera in place of the eye-piece. Captain Waterhouse hardly expected good results with this arrangement, as the definition was bad, and from trials subsequently made on the spectrum of the moon, he is very doubtful whether the spectrum of any thing but the brightest parts of the chromosphere could have been photographed with either instrument. As a preliminary to the eclipse work, Captain Waterhouse made some interesting experiments with Dr. Vogel's method of staining the film with a red or orange dye in order to make it sensitive to the red rays, and by thus using roseine he succeeded in getting photographs of the extreme red of the spectrum. More recently he has found that even the invisible ultra-red heat-rays may be photographed (but reversed, or black for white) by slightly fogging the plate by exposure to daylight.

The Spectra of Nebulæ.—In the *Memorie degli Spettroscopisti Italiani* are given some observations by Professor Bredichin on the spectrum of eight nebulæ, which exhibit three bright lines in the spectroscope. Professor Bredichin did not compare the nebular lines directly with those of a known element, but referred them to the solar spectrum by means of observations taken the next day, so that his results would be affected by any alteration of the instrument, and can therefore only be accepted as approximate, though no sensible change was ever detected. Professor Bredichin concludes that there is no sensible difference in the positions of the lines for different nebulæ, and that the two brighter are identical with two strong lines of iron. This result does not agree with that found by Dr. Huggins, who, by very careful direct comparison, established that the strongest line of the nebulæ was sensibly coincident with one component of the strong double line of nitrogen.

The Solar Atmosphere.—Very various estimates of the absorption due to the sun's atmosphere have been made by different observers, who, with different forms of photometer, have attempted to measure the difference of brightness between the centre and margin of the sun's disk. Thus Arago found the light near the edge to be 97·6 per cent of that from tha centre, while Secchi made it only 22 per cent, a discordance which points to something erroneous in the mode of observation. To decide this question, Mr. Langley has, by means of two reflecting prisms, arranged that the rays from any two parts of an enlarged image of the sun formed by a telescope shall fall on opposite sides of a small disk of paper as if they came from two lights, one on each side of the disk. On the disk is a small grease-spot which is seen bright or dark according as the stronger light is behind or in front of the paper, becoming undistinguishable when the illumination is the same on the two sides, a condition which can be secured by sliding the disk so as to bring it nearer to the fainter light. Mr. Langley has also used Rumford's photometer, in which the two shadows of a small rod cast by the two lights are compared. In this way he found a marked difference in color, the shadow illuminated by the light from the edge being chocolate red, while the other is blueish, and he hence concludes that the sun would become more blue if its atmosphere were removed, while an increase in the depth of the latter would make the sun appear at the same time redder and darker. From numerous observations Mr. Langely concludes that the sun's atmosphere absorbs one half of his light and heat, and granting that four fifths of the temperature of the earth's surface above absolute zero (500° Fahrenheit) is due to the presence of the sun, he infers that an increase in the absorption of the solar atmosphere of 25 per cent would diminish the temperature of our globe by 100° Fahr., reducing it far below that of the glacial epochs. Such a change as P. Secchi has supposed to have taken place between 1852 and 1873 in the sun's atmosphere, in order to account for the difference between his measures of the heat at different parts of the disk, and those made by Mr. Langley, would, therefore, according to the latter, be accompanied by a change of temperature, which is not supported by observation.

TELLURIUM.

An immense excitement has lately broken out in this region, at Sacramento, and elsewhere, over the report that tellurium in great quantities had been discovered on Rock Creek, one fourth of a mile this side of Union Mills, seven miles from this place, and within a hundred yards of Bear River. Until this discovery was made, probably few of our readers ever heard of that strange mineral, of a silvery whitish color, so scarce and highly prized as hardly to admit of any commercial value being placed upon it. From the best information we are able to collect, this metal is used by manufacturers of fine cutlery to give the keenest edge to engraver's tools, surgical instruments, razors, etc., it being supposed that the famous Damascus swords were edged with it; and as an instance of its great value, we are told that a manufacturing firm in San Francisco bought a single pound for which the snug little sum of $3000 was paid. A small mine in Siberia, one in Hungary, and another in Utah, are, we believe, the only sources from which this metal is at present obtained.

The discovery on Rock creek was made in a tunnel of the Bear River Mining Company, opened in their search for iron, and the mineral is supposed to be contained in the ore at the rate of six pounds or more to the ton—enough to make the mine of fabulous richness, should there be no mistake in the matter.

Numerous claims have been staked off, notices posted, and stock is already selling at a lively rate.

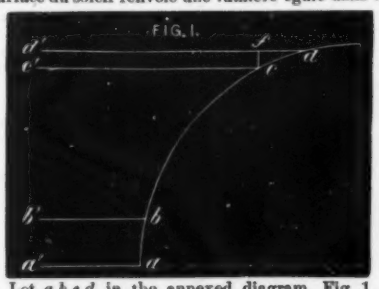
The lead has been traced upward to near the McCourtney place, where it crosses the river and appears on the Placer county side. Another organized company have staked off claims at this point, and will at once proceed to business.—*Wheatland (Cal.) Free Press.*

* I suppose that the action of the ether on the atom under consideration may be represented in some sort in the following manner: Suppose a vertical steel rod, the lower end of which is firmly fixed in the ground. Let a string be attached to its upper end, and suppose that a man holds the other extremity of the string, keeping the string horizontal, and walks or runs round the rod, meanwhile tugging at the string periodically.

[Nature.]

THE DIFFERENCE OF THERMAL ENERGY TRANSMITTED TO THE EARTH BY RADIATION FROM DIFFERENT PARTS OF THE SOLAR SURFACE.

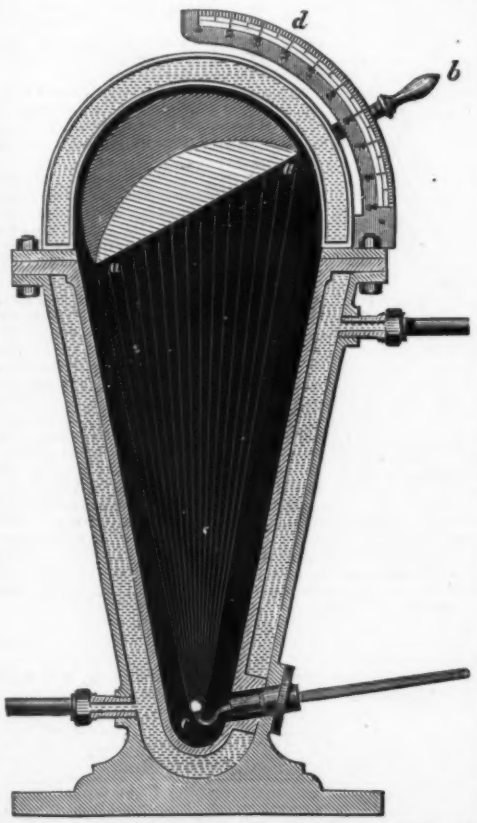
1. PREVIOUS to undertaking a systematic investigation of the mechanical properties of solar heat, I examined thoroughly the merits of Laplace's famous demonstration relating to the absorptive power of the sun's atmosphere, proving that only one twelfth of the energy developed by the sun is transmitted to the earth. The demonstration being based on the assumption that the sun's rays emit energy of equal intensity in all directions, my initiatory step was that of testing practically the truth of that proposition. It has been asserted that Laplace did not propound the singular doctrine involved in such a proposition; I therefore feel called upon, before proving its unsoundness, to quote the words employed by the celebrated mathematician. (See "Méchanique Céleste," tome iv. page 284.) Having called attention to the fact that any portion of the solar disc as it approaches the limb ought to appear *more brilliant* because it is viewed under a *less angle*, Laplace adds: "Car il est naturel de penser que chaque point de la surface du soleil renvoie une lumière égale dans tous les



sens." Let *a b c d*, in the annexed diagram, Fig. 1, represent part of the border of the sun, and *b a*, *c d*, small equal arcs; *a a'*, *b b'*, *c c'*, *d d'*, being parallel rays projected towards the earth. Laplace's theory asserts that owing to the concentration of the rays the radiation emanating from the portion *d c* transmits *greater* intensity towards the earth than *b a*, in the proportion of *c d* to *f c*. The proposition is thus stated in "Méchanique Céleste": "Call θ the arc of a great circle of the sun's surface, included between the luminous point and the centre of the sun's disc, the sun's radius being taken for unity; a very small portion *a* of the surface being removed to the distance θ from the centre of the disc, will appear to be reduced to the space $a \cos \theta$; the intensity of its light must therefore be increased in the ratio of unity to $\cos \theta$."

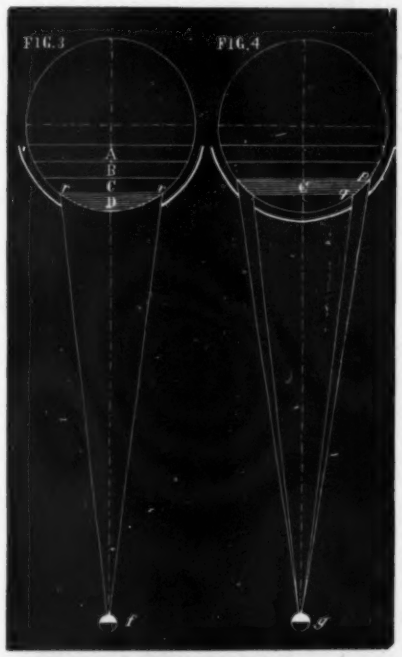
2. In order to disprove the correctness of the stated demonstration, I have measured the relative thermal energy of rays projected in different directions from an incandescent metallic

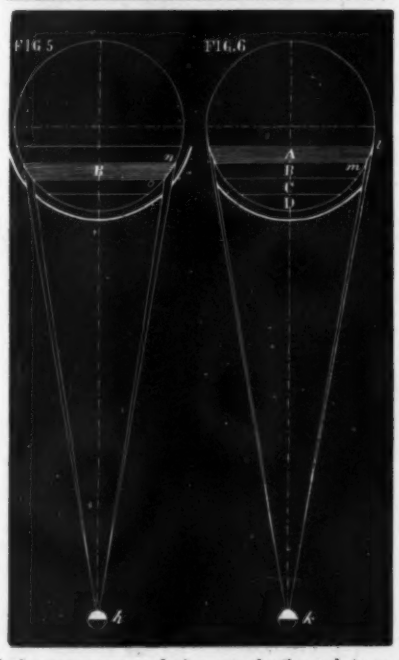
FIG. 2.



disc, by the following method: Fig. 2 represents section of a conical vessel covered by a movable semi-spherical top, the vessel being surrounded by a jacket through which water my be circulated. A revolving circular disc, *a a*, composed of cast iron, the back being semi-spherical and protected by fire-clay, is suspended across the top of the conical vessel supported by horizontal journals attached at opposite sides. The angular position of the disc is regulated by a radial handle, *b*, connected to one of the journals; the exact inclination to the vertical line being ascertained by means of a graduated quadrant, *d*. An instrument, *e*, capable of indicating the intensity of the radiant heat transmitted by the incandescent disc, is applied at the bottom of the conical vessel. The mode of conducting the experiment is extremely simple. The movable cover and its lining of fire-clay having been removed, the cast-iron disc is heated in an air-furnace to a temperature of 1800° F. It is then removed by appropriate tongs, and suspended over the conical vessel, the lining and cover being quickly replaced. The temperature, shown by the instrument at the bottom of the conical vessel, resulting from the action of the radiant heat of the disc, is then recorded for every tenth degree of inclination. The investigation, it may be briefly stated, shows that the temperatures imparted by radiation to the recording instrument is exactly as the sines of the angles of inclination of the disc. Hence, at an inclination of 10° to the vertical line, the temperature imparted to the thermometer is scarcely one sixth of that imparted when the disc faces the thermometer at right angles; yet in both cases an *equal amount of surface of an equal degree of incandescence* is radiating towards the instrument. Laplace and his followers have evidently overlooked this important and somewhat anomalous fact, proving that radiation emanating from heated bodies is incapable of exerting full energy in more than one direction. Our practical experiments with the revolving incandescent disc have thus fully demonstrated the truth of the proposition intended to be established, namely, that the rays emanating from incandescent planes do not transmit heat of equal energy in all directions, the energy transmitted being as stated, proportionate to the sines of their angle of inclination to the radiating surface.

3. The next step in the investigation of solar heat, before adverted to, was that of measuring the radiant energy transmitted in a given direction by an incandescent solid metallic sphere. For this purpose I employed a double conical vessel similar to the one represented in Fig 2, the incandescent sphere being suspended over the conical vessel in the same manner as the revolving disc. The nature of the arrangement will be readily understood by inspecting the annexed diagram, which represents four spheres, Figs. 3, 4, 5, and 6, each sphere being divided into four zones, A, B, C, and D, occupying unequal arcs, but containing equal convex areas. Semi-





spherical screens composed of non-conducting substances were applied below each sphere, provided with annular openings, arranged as shown in the diagram. Through these annular openings the radiant heat from the incandescent zones, D, C, B, and A, was transmitted to the thermometers, *f*, *g*, *h*, and *k*, respectively. Père Secchi, and other followers of Laplace, will be surprised to learn that when the suspended sphere was maintained at a temperature of 1800° F., the radiation from the zone C, Fig. 4, imparted a temperature of 27°·49 F. to the thermometer *g*, while the radiation from the zone A, Fig. 6, imparted only 6°·19 F. to the thermometer *k*. Let us bear in mind that the radiating surface *l m* of the zone A is equal to the radiating surface *p q* of the zone C. The stated great difference of temperature produced by the radiation from zones of equal area furnishes additional proof that Laplace based his remarkable analysis on false premises. "The sun's disc ought to appear more brilliant towards the border, because viewed under a less angle," we are told by the great analyst. The instituted practical tests, however, prove positively that the energy of the rays projected from the border of an incandescent sphere is greatly diminished *because viewed under a less angle* from the point occupied by the recording thermometer.

4. The result of our experiment with the revolving incandescent disc shows that if the small arc *b a*, in Fig. 1, be reduced until the field represented by *b' a'* becomes equal to the field represented by *c' d'*, the radiant energy transmitted through each of those fields will be alike; the reason being that the number of rays of diminished intensity passing through *c' d'* will be as much greater than the number of rays of maximum intensity passing through *b' a'* as *c d* is greater than the reduced *b a* = *f c*. It should be observed that *c d* is so small that we may without appreciable error regard it as a straight base, and *f c* as the sine of the angle *c d f*. It follows from this demonstration that if the solar atmosphere exerted no retarding influence, the radiant heat transmitted towards the earth would be alike for equal areas of the solar disc—more correctly, for areas subtending equal angles, since the receding part of the solar surface is at a greater distance from the earth than the central part.

Encouraged by the practical result of the instituted investigation, I devised the method described in *Nature* (vol. xii. p. 517), showing that the polar and equatorial regions of the solar disc transmit radiant heat of equal intensity to the earth, and that the sun emits heat of equal energy in all directions. Adopting Secchi's doctrine relating to the retardation suffered by calorific rays in passing through atmospheres, namely, that the diminution of energy is as the depth penetrated by the rays, it may also be shown, by an easy calculation based on the result of our investigations, that the absorption by the solar atmosphere can not exceed one seventh of the radiant energy emanating from the photosphere.

5. Concerning the plan resorted to by the Director of the Roman Observatory, and others, of investigating the sun's image instead of adopting the method of *direct* observations, I will merely observe that the information contained in the several works of the Roman astronomer furnishes the best possible guide in judging of the efficacy of *image investigation*. Let us select his account of the investigations conducted between the 19th and 23d of March, 1852. Having pointed out that in these experiments it was impossible to approach within a minute of the edge of the sun, and that during a later observation—date not mentioned—he had approached within a minute, the investigator observes: "But at this extreme limit, even making use of the most accurate means of observation, we find difficulties which it is impossible to overcome completely." In addition to this emphatic expression regarding the difficulties encountered, the author adds: "Moreover, it is impossible to study the edge alone, for the unavoidable motions of the image do not admit of its being retained at exactly the same point of the pile; we have therefore been unable to push the exactness as far as we hoped; and we have discontinued the pursuit of these researches, although the results obtained are quite interesting." (See revised edition of "Le Soleil," vol. i. p. 205.) It is needless to institute a comparison between a system of which its founder speaks so despondingly, and one which enables us to push our investigations to the extreme limit of the solar disc, admitting of entire zones being viewed at once, instead of only small isolated spots.

J. ERICSSON.

COBALT ELECTROPLATING.

By I. ADAMS, JR., Boston, Mass.

I HAVE found that the simple salts of cobalt, when associated with another electrolyte—such as the chloride of ammonium, or the sulphate of ammonia, or the chloride of magnesium, or the sulphate of magnesia—can be used so as to produce good results in practical cobalt-plating; and I find that no good results can be obtained except by the use of a simple salt of cobalt in combination with some other electrolyte of the alkalies or alkaline earths.

The best of such combined salts are, the chloride of cobalt and ammonium, the chloride of cobalt and magnesium, the sulphate of cobalt and ammonia, or the sulphate of cobalt and magnesia.

In order to produce the best results, the cobalt solutions should, in use, be neutral, and (except in covering poorly conducting surfaces) in no case acid.

I proceed as follows: Dissolve a given weight of the oxide of cobalt in hydrochloric acid. To this solution add, for every pound of oxide used, a half pound of the chloride of ammonium. Then filter the solution, if necessary, and to it add sufficient ammonia to render the solution strongly ammoniacal. Then allow this ammoniacal solution to stand, with occasional brisk stirring, until it becomes of a wine-red color. Then add an excess of commercial muriatic acid, and raise the whole to the boiling-point, and wash the light purple precipitate by decantation with cold water several times. Throw the precipitate upon a cloth filter, wash again with cold water, and allow it to drain and dry, and then heat the dried salt to a low red heat in a crucible or other suitable vessel, and a chloride of cobalt will be produced practically free from impurities.

To produce the chloride of cobalt and ammonium, make a solution by dissolving three ounces of the chloride of cobalt and two ounces of pure chloride of ammonium to each gallon of the solution.

To produce a solution of the chloride of cobalt and magnesium, make a solution as above, substituting chloride of magnesium for the chloride of ammonium.

To produce a solution of the sulphate of cobalt and ammonia, dissolve the chloride of cobalt in water, and for every five parts of such dry salt add four parts, by weight, of sulphuric acid and evaporate to dryness; redissolve in water and add five parts of pure sulphate of ammonia. If there should be an excess of acid, neutralize with ammonia.

To produce the sulphate of cobalt and magnesia, make a solution as just directed, substituting sulphate of magnesia for sulphate of ammonia.

The method for producing a suitable anode to be used with these solutions is as follows: Precipitate the chloride of cobalt with potash, soda, or carbonate of ammonia; then make a solution of tartaric acid, about three parts of acid to two parts of dry chloride, and add to it the moist oxide of cobalt, and raise the whole to the boiling-point. A tartrate of cobalt is formed, which throw upon the filter and wash several times with boiling water, dry, mix with a little lamp-black or other suitable form of pure carbon, and heat to whiteness in a closed Hessian or other suitable crucible. The tartrate of cobalt is thus reduced to the metallic state and fused, and can then be readily cast into plates or anodes of any desirable form.

After the solutions and anodes have been prepared as herein described, cobalt may be readily and continuously deposited; but in order to carry on the deposition of cobalt continuously, it is necessary to observe certain precautions. First, great care should be exercised, in preparing the work for plating, that none of the acid or alkaline dips should be introduced into the solution. Second, a not too high battery-power should be used; a strength of current of two Smee cells is sufficient.

In plating articles of zinc with cobalt, it is first necessary to coat them with copper.

[Live Stock Journal.]

THE OCTAGON BARN.

AT the suggestion of a gentleman of Buffalo, greatly interested in improved methods of building, Mr. L. Brush, we give a representation of an octagon basement, laid out, in the interior, on a circle, containing fifty-two stalls for cows or cattle, with heads towards the interior. For a fancy breeding establishment, these stalls might be made some three feet high, showing all the animals at one view, and with the feeding-car on track *C*, and the car for running out manure on track *A*, the labor would be made convenient. This leaves a fifty-two-foot interior circle which may be put to any purpose required. The track *C* takes out six feet, still leaving a circle of forty-six feet diameter. The horse-stalls *D* are laid out on a circle, but would be better placed at right angles with the drive-way. One strong point to be made in favor of the circular plan is, that by means of the cars running across the drive-way, food dropped through the floor above upon the car can be run to every animal in the basement. The horse-stalls would also be very convenient of access from the drive-way. One side of the drive-way might be fitted up with box-stalls for brood mares or colts, or calf-pens. We give this plan merely as suggestive, and not as the best arrangement. Every one may divide the space as he sees fit. Of course, it will be more expensive to fit up on a circle, but to one who fancied it, a few dollars would be, perhaps, no objection. In the basement, if wanted for a large dairy barn, there is room for two parallel floors with two rows of cows to each floor, giving one long and one short row of cows to each floor, affording ample room to drive a cart behind each row of cows to take away the manure. One drive-way would answer for both inside rows of cows; also leaving room for a narrow calf-pen on the outside wall behind each outside row of cows. This would be occupying the basement to its full capacity, but, usually, on a 250-acre farm, which this size of octagon would accommodate, not more than fifty head of cattle and horses are kept, and our first plan of basement would be the most convenient, leaving ample space for a great variety of uses.

OPEN-BOARDED FLOOR.

The platform is to be raised eighteen inches, and the floor two feet six inches wide, behind the stanchions or manger, will be of ordinary plank, or tight. Upon this the fore-feet will stand. Then a space three feet wide will be laid with 2 x 3 oak scantling, set on edge, and two inches apart, blocks being placed between them to hold them firmly in position. The hind-feet stand upon this open floor, and the manure falls through upon a concrete bottom below; thus preserving both liquid and solid. A sliding-board will be placed under the open floor, to carry the manure towards the outside. A cart or wagon will be driven behind this platform, and the manure carried directly to the field. The basement being eight and one half feet high, there will still be seven feet above this platform, a space sufficient for cattle. From the door to the platform there is a bridge up to the platform. The platform is seven feet wide, and has a railing on the back side to prevent the cows from going off.

Dry earth or muck must be kept in the basement near this platform, and a little thrown each day on the open floor, falling through upon the manure, and thus preventing all smell and fixing the ammonia, rendering manure and dry muck equally valuable. Any dry earth, such as cleaning of ditches or headlands, will answer every purpose, when dry and pulverized. This will double the amount of manure, and all be more valuable than manure kept in the common way.

CONCRETE WALL.

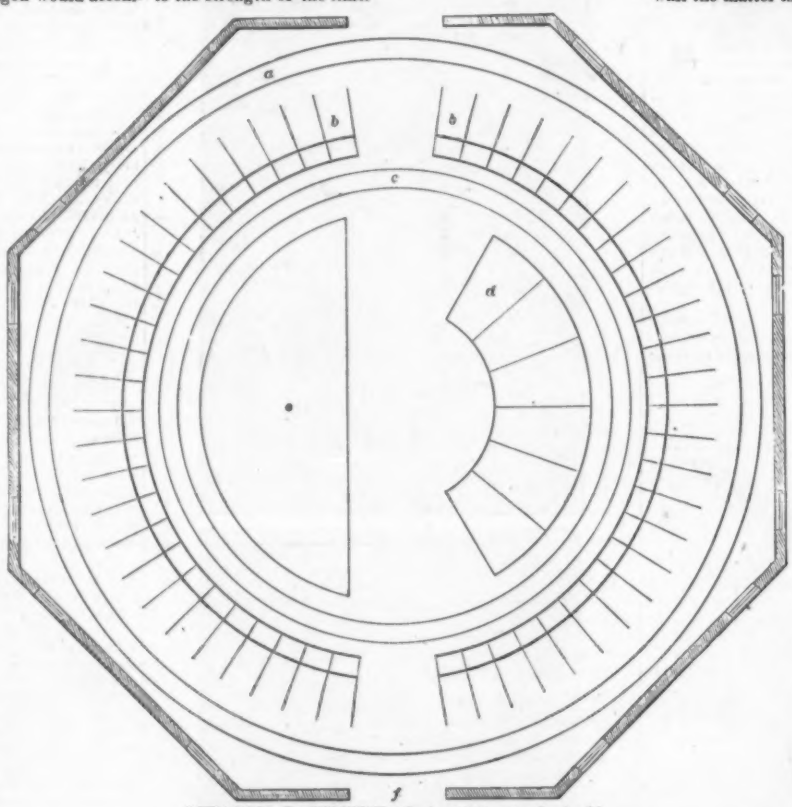
The advantages of this mode of building walls are not sufficiently known, for when fully understood, this wall must come into more general use. In many parts of the country suitable stone is not to be had, and, where stone is plenty, this mode of using them is far preferable to the ordinary way of building a wall. The concrete, which would build a wall alone, may be used to cement the stone together, and thus save the cement which would occupy the space of the stone. In many parts of the country, small flat stones are thrown out by the plough and need to be gotten off the field. These will work into the concrete wall and make an excellent job. They will have a firm bearing upon each other, and thus render the wall strong before it sets hard. Care should be taken not to let stone come quite to the surface of the wall, but cover their edges with concrete. Concrete is more porous than stone, and will not conduct heat and cold like stone. A concrete wall will show no frost on the inside in winter, is drier and cooler in summer, and warmer in winter, than stones, and, therefore, it is well not to let the stone come within three fourths inch of the outside. You can use any kind of cobble or irregular hard stone in this kind of wall, but it may be built of clear sand, or sand and gravel, the gravel being large or small, and stone may be mixed with the sand and gravel.

WATER-LIME CONCRETE FOR FOUNDATIONS.

If there is moisture to come to the wall, water-lime must be used, and it is well to carry two or three feet above the ground with concrete. The place should also be excavated one or two feet beyond the proposed wall, so as to leave an air-space on the outside, giving the wall a chance to dry and become hard. If, in any case, you go into the slate rock, which is always full of seams charged with moisture, you must not allow the concrete to be built against this rock, for the moisture in the rock coming into the thin mortar, will cause the milk of lime to run out and leave an infinite number of fine pores through which water will run; but if no water is allowed to come to it while drying, it will be water and air tight. It is also well to have a drain cut lower than the bottom of the wall on the outside, to carry off any water that might otherwise come against it, which will render the basement dry.

PROPORTIONS OF WATER-LIME CONCRETE.

If you have only sand to use, mix five parts with one of water-lime, thoroughly, while dry; then wet into a thin mortar and use immediately. But if you also have gravel, mix the sand and water-lime, four to one, then mix into this five or six of gravel, make into thin mortar and use at once. This will make a concrete of about nine to one. If you also have stones to lay with it, put these stones into the boxes and cover with this mortar, and all the stone you put in will save so much mortar and make your wall stronger while new. If you use only sand and stone, then mix the water-lime five to one, lay the stone with it. The way is to put a layer of an inch of mortar in the bottom and then a layer of stone, then of mortar and so on, letting the mortar come over the edge of the stone.



OCTAGON BASEMENT (Scale, 16 feet to the inch).

EXPLANATION.—This represents an 80-foot octagon basement laid out on a circle; *b b* represents 52 cow or cattle stalls, heads toward inner circle; *c* represents a circular track for a feeding-car to run around in front of the cows or cattle; *a*, circular track for a manure-car to carry off offal; *d* represents one method of placing horse-stalls convenient to drive-way; *e*, vacant space to be used for any purpose; *f f*, drive-way.

PROPORTIONS OF QUICK-LIME CONCRETE.

If only a basement wall is built, you may use water-lime for it all; or when you get so far above the ground that moisture will not affect it, you may use quick-lime, which is cheaper, and goes farther. If you live near a lime-kiln, it will be cheaper to get the fine air-slacked lime about the kiln, which will answer just as well, if you estimate only the fine lime and not the small stones in it. In mixing this concrete, take ten of sand and one of lime, slaking the lime thin before you mix in the sand; now mix in ten or twelve parts of gravel, fine and coarse, and use this as a mortar to make the wall or lay the stone. Mix it all well together, and then wheel in a barrow and shovel into the wall-boxes. The sand and lime will fill all the spaces between the gravel and the stone, if you have any stone, cementing all together. The quick-lime may be mixed some time before using, as the mortar is all the better for it; but it does not set so quick as water-lime, and must have more time between layers. But a quick-lime concrete is more porous, and, consequently, drier and cooler in summer and warmer in winter. The proportions will vary according to the strength of the lime.

CONSTRUCTING THE BOXES FOR THE WALL.

Having determined the place and excavated for the wall, construct the boxes as follows: Take 3 x 4 scantling for the standards, a little longer than the wall is high; place these on each side of the proposed wall, as far apart as the thickness of the wall and the thickness of the plank for the boxes. The plank should be fourteen inches wide, one and one half inches thick, and of a length to accommodate the wall. If the wall is thirty-two feet long, then sixteen-feet plank will be the right length. These standards would thus be placed fifteen inches apart; placing the plank inside the standards would leave twelve inches for the wall. These standards are held the proper distance at the bottom by nailing a thin piece of board across under the lower end, and the tops fastened with a cross-piece. The wall is built over these pieces at the bottom, and they are left in the wall. The standards are plumbed, and made fast by braces outside. Now, it will be seen that these plank can be moved up on the inside of the standards as fast as the wall goes up. The plank on the outside of the wall will, of course, be longer than those on the inside by the thickness of the wall. The door-frames will have jams as wide as the wall is thick, and will make standards for that place. There will be a pair of standards at each end of the plank; but the pair in the middle of the wall will hold the ends of both plank. To hold the plank from springing out between the standards, take a piece of narrow hard-wood board, two feet long, bore a two-inch hole at each end, having fifteen inches between them; put a strong pin, two feet long, through these holes some ten inches; now these pins will just fit over the outside of the box-plank, and by putting a brace between the upper ends, will hold them tight against the plank, preventing their springing out. Two of these clamps will be required for each set of plank sixteen feet long. Now, when the box-plank are placed all around the wall, begin and fill in the concrete mortar and stone, as described; and when you get round, if water lime is used, you may raise the plank one foot and go around again, raising the wall one foot each day, if you have men enough. You will place the window-frames in the boxes when the wall is raised high enough to bring the top of the frame to the top of the proposed wall. The jams and sills of the window-frames will be as wide as the door-frames.

COST OF THE CONCRETE WALL.

The cost of the concrete wall for the basement of the 80-foot octagon—265½ feet long, 15 inches thick at the bottom, 12 inches at top, containing 2535 cubic feet—was $350; the items being as follows: water-lime, 65 barrels, $90.35; lumber for door and window-frames and board on top of wall, $19.34; carpenter-work, making window and door-frames, fitting and plumbing standards, fitting plank-boxes for wall, etc., $41; getting material, and the labor of laying the wall, $99.31, or about ten cents per cubic foot. This was the cost of a water-lime concrete, quick-lime costs less. In this case the old wall was used as far as it went, but it cost extra in labor of preparing it, as much as to have obtained new material. Of course, the cost of a concrete wall will depend upon the convenience of getting sand, gravel, stone and lime. It would take more lime to build altogether with fine sand, as the fine grains have so much greater surface to be coated with lime, but with sharp sand, one of water-lime to six of sand, makes a solid wall, great care being taken to mix the sand and lime well together while dry. Mixed in this proportion, it would cost about six cents per cubic foot for the lime, but quick-lime, for the wall above the line of moisture, would cost about half as much. Yet it must be remembered that flat stone usually cost about ten cents per cubic foot, or the full cost of a concrete wall.

In building a concrete wall, the labor is very much less, as the help required to tend a mason will build more feet of concrete than the mason and tender both, on the common wall.

PLACING CONCRETE WALL UNDER OLD BUILDINGS.

It is often desirable to raise a building and put a wall under it, but when laid with stone in the ordinary way, the shores or blockings are in the way of the wall. With a concrete wall the matter is easy. Raise the building to the height desired, level it on the blockings; then place 3 x 4 scantlings plumb under the centre of the sills, in sufficient number to hold the building exactly in position, brace these from the top and take out the blockings. Now set the standards, place box-plank and build the concrete around these scantling. They will be in the centre of the wall and will not injure the wall by rotting. In this way a building may be raised and a wall put under it very cheaply; 40 x 40 may have a wall eight feet high for only $128. The cost would be repaid the first winter in the saving of food in wintering the stock. The concrete wall is so tight as to exclude the air, and windows may be put into the wall wherever desired, except at the drive-ways. We urge this method upon farmers, because they may thus have a warm stable, at a small expense, without erecting new buildings.

CULTURE UNDER GLASS MADE EASY.

MR. JAMES DOUGALL, of Windsor, Ont., a respectable and experienced nurseryman and fruit-culturist, has recently given publicity to the following plan which he has tried successfully.

The sashes are made stationary, but are fastened with screws, to admit of being taken off for repairs. They extend from the front wall of the building to within ten inches or a foot of the back wall. The space thus left is supplied with sheet-iron shutters, or ventilators, which are closed in winter, but left open from the time the vines are uncovered in the spring until they are laid down in the fall. The chief peculiarity of the method is in the laying of the glass. It is neither lapped nor puttied. The panes are laid end to end, fastened in their places with bits of tin, and a space of half an inch left between every third or fourth pane. By this means the rain, when it falls, is pretty evenly distributed throughout the house. Ventilation as well as watering is amply secured by these openings. It must be observed that the ventilation is all obtained at the top of the building, experience having shown that draughts are hurtful to the plants. Water and air being thus provided for, no more attendance is required for these in-door vines than for out-door ones, except that the fruit must be thinned about one half when a third grown, to give the berries a chance to fill out to their utmost size.

MR. DOUGALL states that he has been perfectly free from such troubles as mildew and red spider, and has grown fine samples of Black Hamburg, Muscat Hamburg, and other choice grapes by this plan.

PRESERVING MEAT.

By A. HERZEN, Florence, Italy.

THIS invention relates to the preservation of fresh uncooked meat and other animal food, such as fowl, game, and fish, in its natural condition, without change of color or flavor, and to the application of inexpensive materials for that purpose.

I employ a mixture of borax and boracic acid in their native crude, and, consequently, cheapest form, with a little salt and saltpetre, whereby the natural color of the meat is retained. The proportions in which these substances are mixed may be somewhat varied; but about one hundred and fifty parts, by weight, of boracic acid with thirty parts of borax, fifteen parts of common salt, and five parts of saltpetre form a mixture well adapted for the purpose. This mixture I dissolve in about ten times its weight of hot water, and allow the solution to cool. I then throw the joints or parts of the animal to be preserved into the cold solution, and allow them to remain therein from twenty-four to thirty-six hours, after which they are taken out and closely packed for transport in barrels or cases. I prefer to bed the meat in melted fat of the same kind, so that it is covered thereby.

When the meat thus preserved is to be used, it is rapidly washed with cold water and wiped before cooking. The very small quantity of the antiseptic ingredients remaining in the meat has no effect upon its flavor, nor do these ingredients affect the health of the consumer, as they are of a perfectly innocuous character, even when taken in considerable quantity.